HOUSE OF COMMONS SESSION 1996–97

SCIENCE AND TECHNOLOGY COMMITTEE

Third Report

THE NATURAL ENVIRONMENT RESEARCH COUNCIL

Volume II

Minutes of Evidence and Appendices

Ordered by The House of Commons *to be printed*
12 March 1997

LONDON : THE STATIONERY OFFICE
£15·90

HC 81-II
[incorporating HC 687 of Session 1995–96]

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HOUSE OF COMMONS SESSION 1996–97

SCIENCE AND TECHNOLOGY COMMITTEE

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The Science and Technology Committee is appointed under Standing Order No 130 to examine the expenditure, administration and policy of the Office of Science and Technology and associated public bodies.

The Committee consists of 11 Members. It has a quorum of three.

The Committee has power:

(a) to send for persons, papers and records, to sit notwithstanding any adjournment of the House, to adjourn from place to place, and to report from time to time;

(b) to appoint specialist advisers either to supply information which is not readily available or to elucidate matters of complexity within the Committee's order of reference;

(c) to communicate to any other such committee and to the Committee of Public Accounts and to the Deregulation Committee its evidence and any other documents relating to matters of common interest; and

(d) to meet concurrently with any other such committee for the purposes of deliberating, taking evidence, or considering draft reports.

Unless the House otherwise orders, all Members nominated to the Committee continue to be members of it for the remainder of the Parliament.

The following were nominated Members of the Committee on 13 July 1992:

Mr Spencer Batiste	Sir Giles Shaw
Dr Jeremy Bray	Sir Trevor Skeet
Mr Malcolm Bruce	Dr Gavin Strang
Mrs Anne Campbell	Sir Gerald Vaughan
Cheryl Gillan	Dr Alan W Williams
Mr William Powell	

Sir Giles Shaw was elected Chairman on 15 July 1992.

On 9 November 1992 Mr Malcolm Bruce was discharged and Mr Andrew Miller added to the Committee.

On 16 November 1992 Dr Gavin Strang was discharged and Dr Lynne Jones added to the Committee.

On 7 November 1995 Cheryl Gillan and Mr William Powell were discharged and Mr Ian Bruce and Mr Patrick Thompson were added to the Committee.

The cost of preparing for publication the shorthand minutes published with this Report was £3,110.14.
The cost of printing and publishing this Volume is estimated by The Stationery Office at £6,970.

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R F P Hardman, Director, Exploration Business, Amerada Hess Limited (NEE 35)

M Bittleston, The Meteorological Office (NEE 39)

MINUTES OF EVIDENCE

TAKEN BEFORE THE SCIENCE AND TECHNOLOGY COMMITTEE

WEDNESDAY 24 JULY 1996

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste	Dr Lynne Jones
Dr Jeremy Bray	Mr Andrew Miller
Mrs Anne Campbell	Sir Trevor Skeet

Letter to the Clerk of the Committee from Professor John Krebs, FRS, Chief Executive, Natural Environment Research Council (26.4.96)

Thank you for the FAXed copy of your letter of 3 April which had gone astray in the post. I hope that the following brief comments will be of assistance to the Committee at their next meeting.

AREAS OF RESEARCH/RESEARCH TOPICS

NERC's mission can be simplified as "knowledge, understanding and prediction of the environment and its resources". Most of the portfolio can be analysed in terms of contributions to six Environmental and Natural Resource Issues on the UK Agenda—Biodiversity, Environmental Risks and Hazards, Global Change, Natural Resources, Pollution, and Waste. Two extensive consultations carried out in 1995 have helped to identify 10 key Scientific Challenges for the next 5-10 years and 15 Environmental Foresight Topics where science can contribute to longer term market opportunities. Further details may be found in the enclosed booklet "Environmental Directions".

ISSUES OF PARTICULAR INTEREST TO NERC

Flexibility

Creating the flexibility needed to start new initiatives identified through our own priority setting mechanisms and Technology Foresight is a key issue for NERC. We have to work within constraints caused by:

- Government ring fencing of some elements of the NERC budget (in particular the funding for the British Antarctic Survey which accounts for 14 per cent of the 1996–97 Science Budget);
- Government initiatives such as ROPAs, Equipment, and Foresight Challenge which impact on flexibility and also drive wedges into the NERC baseline by not providing full funding for initiatives;
- high fixed costs in terms of infrastructure and salaries which cannot be reduced without prior investment, for example to meet the costs of further rationalisation.

The funding of new large facilities is a particular concern within this context. The provision of replacements for ships and aircraft and up-grading of high performance computing facilities will, for example, all be important for the environmental sciences in the medium-term. We are aware that provision of such facilities is not viewed with favour within OST and that top-slicing of the Science Budget will no longer be an option. This, together with the reduction in internal flexibility, means that it is difficult to see how future provision will be managed.

The impact of cuts in other Government Departments

Cuts in R&D spend by other departments can have a knock-on-effect on Research Councils. This could be even more serious in the future as, in the spirit of the 1993 White Paper, we are increasingly looking towards co-funding of science programmes with departmental end-users. Examples of recent and potential impacts include:

- late withdrawal by DOE from the NERC Large Scale Processes in Ecology and Hydrology programme which has meant that at least four projects could not be funded;
- changes in DTI hydrocarbon commissions with the BGS which has led to fragmentation of hydrocarbon data, impacting on NERC's capability to act as a repository for national data in this area;

- MOD cuts of £2.5 million to the C130 flight which will impose significant additional costs on NERC if the facilities for atmospheric science provided by these flights are to be continued;
- other departments are seeking to reduce their levels of attribution for EU programmes by arguing that the strong involvement of the science and engineering base in delivering EU research should result in more attribution being ascribed to OST and thus to the Research Councils;
- discussions within the British National Space Centre on the future funding of the overall UK Earth Observation Programme. NERC is currently concerned with building instruments and the interpretation and use of earth observation data for environmental and natural resource assessments. Any change in the pattern of funding to include responsibility for launch vehicles and platforms would impact significantly on NERC.

The impact of Prior Options

We are at present in the middle of this process. Three of the NERC Centres/Surveys are being subjected to Prior Options Reviews—the British Geological Survey, the Centre for Coastal and Marine Sciences, and the Centre for Ecology and Hydrology—with a deadline for report to Ministers by the end of July.

Funding for basic research

You may be aware that the latest OECD Frascati manual allows for the optional breakdown of basic research into "pure basic" (defined as advancement of knowledge without working for long-term economic or social benefits) and "oriented basic" (carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised or expected current or future problems). Other categories, as before, are "strategic-applied" and "specific applied".

As a mission-based Research Council we have taken the view that the proportion of "pure basic" research that we support will be limited and that much of our basic research falls into the "basic oriented" category. With this in mind we do distinguish between support given in the purely responsive "non-thematic" mode and that where proposals are invited against themes -"thematic" and "core-strategic" modes.

NERC support given to non-thematic "curiosity driven" research currently represents 20 per cent of Science Budget. Although Council has not yet taken a formal view on this level it is unlikely that it would wish to see it diminished. There is also basic research done under the thematic and core-strategic modes.

Relationship with the university sector

The key issue for the future is whether we should be more proactively selective in where we place studentships and grants. Currently some 75 per cent of grants go to a top 20 of universities and 1.4 per cent to former polytechnics.

I would of course be happy to provide further information if the Committee wishes to follow up any of these points in more detail. I will aim to come back to you on your questionnaire by 10 May.

Memorandum submitted by the National Environment Research Council (16.5.96)

NERC RESPONSE TO QUESTIONNAIRE

Since a number of the questions relate to funding issues, our response is prefaced by information on the New Funding Model that is being introduced within NERC and which will be fully effective from 1 April 1997, and comments on the definitions of R&D in the latest Frascati manual.

THE NEW FUNDING MODEL

NERC funding is expressed in terms of four funding modes:

- Core Strategic funding maintains expertise and knowledge in key areas of the environmental sciences determined by Council. Typically long term it supports excellent and relevant research, survey and monitoring; technology development; and the curation, interpretation and supply of environmental data. It meets current needs and forms a basis for meeting future priorities.
- Thematic funding encourages scientific excellence and contributes to wealth creation and quality of life through basic, stategic and applied science, technology development, and training, within selected themes. Council's strategic planning, including inputs from Technology Foresight, identifies these themes.

- Non-thematic funding fosters excellence by supporting curiosity-driven research, training, and technology development, in areas selected by applicants.
- Infrastructure funding provides essential support, equipement, services and facilities for the NERC community.

FRASCATI DEFINITIONS OF R&D

Recognising that the boundary between between basic and applied R&D is often subjective, the latest OECD Frascati manual allows for the following optional breakdowns:

- Pure basic research the advancement of knowledge, without working for long-term economic or social benefits and with no positive efforts being made to apply the results to practical problems or to transfer the results to sectors responsible for its application.
- Oriented-basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised or expected current or future (practical) problems or possibilities.
- Strategic-applied research where the work, although directed towards practical aims, has not yet advanced to the stage where eventual applications can be cleared specified.
- Specific-applied research which is not strategic in nature and which will have quite specific and detailed products, processes, systems etc as its aims.

The wider terms strategic research is seen as embracing orientated basic and strategic-applied research, describing work that has evolved from pure basic research and where practical applications are likely and feasible but cannot yet be specified, or where accumulation of underlying technological know-how will serve many diverse purposes.

QUESTION 1: WHAT ARE THE COUNCIL'S MOST IMPORTANT FUNDING AREAS?

(a) *For public interest and policy related issues*

Most of the NERC portfolio can be analysed in terms of contributions to six major issues on the UK's environmental and natural resource agenda. The outcome for 1996–97 is shown in Table 1. This covers NERC Science Budget funding in all four modes and also External Funding.

Table 1

ANALYSIS OF TOTAL NERC BUDGET IN TERMS OF ENVIRONMENTAL AND NATURAL RESOURCE ISSUES (ENRIs)

	Science Budget £k	*(%)*	*External Funding £k*	*(%)*
Biodiversity	14,000	(8.5)	3,000	(7)
Environmental risks and hazards	12,000	(7.5)	5,500	(15)
Global change	45,000	(27.5)	1,000	(4)
Natural resources	55,000	(33)	15,000	(38)
Pollution	19,000	(11.5)	8,000	(21)
Waste	5,000	(3)	5,000	(14)
No specific allocation	15,000	(9)	500	(1)

(b) *For basic research*

NERC is committed to promoting and supporting basic research aimed at improving understanding of the Earth's environment and environmental processes. Such basic understanding supports the development of more strategic and applied studies of environmental and natural resource issues. As a mission-based Research Council this basic research is primarily of the "oriented basic" type in OECD terms.

Support for basic research and training is provided through NERC's non-thematic funding mode and also alongside strategic/applied research within NERC's thematic and core strategic funding modes.

Table 2 shown the 1995–96 science area breakdown of funding for basic research and training through the non-thematic mode only. It is not possible to provide comparable information for the basic element of thematic and core strategic funding.

Table 2

NON-THEMATIC BASIC RESEARCH AND TRAINING FUNDING, ACCORDING TO SCIENCE AREAS

	Research grants (£K)	*Training awards and Fellowships (£K)*
Atmospheric S & T	1,326	740
Earth S & T	6,355	3,881
Earth Observation S & T	981	678
Marine S & T	2,721	1,716
Freshwater S & T	2,196	1,344
Terrestrial S & T	5,256	3,702

(c) *For strategic/applied research*

In addition to analysis on the basis of ENRIs (see Table 1), another approach is to analyse NERC funding in relation to the outcomes of Technology Foresight. NERC's thematic and core strategic programmes have recently been analysed in terms of the recommendations of the National Technology Foresight Steering Group (Table 3), the Technology Foresight Panels (Table 4) and NERC's own generic Environmental Foresight Topics distilled from the reports of the Panels (Table 5). Figures are for 1996–97.

Table 3

ALIGNMENT OF NERC THEMATIC AND CORE STRATEGIC PROGRAMMES AGAINST TECHNOLOGY FORESIGHT STEERING GROUP RECOMMENDATIONS

	£K	*% Science Budget*
Modelling, simulation and prediction of complex systems	18,952	11.5
Sensors and sensory information processing	9,084	5.52
A cleaner world	56,472	34.29

Table 4

ALIGNMENT OF NERC THEMATIC AND CORE STRATEGIC PROGRAMMES AGAINST FORESIGHT PANELS

	£K	*% Science Budget*
Chemicals	5,228	3.17
Construction	1,887	1.15
Financial services and insurance	3,487	2.12
Health and life sciences	4,245	2.58
Transport	8,174	4.96
Communications	—	—
Food and drink	8,660	5.26
IT and electronics	—	—
Manufacturing	6,617	4.02
Materials	11,327	6.88
Agriculture, natural resources and environment	21,852	13.27
Defence and aerospace	—	—
Energy	28,154	17.09
Leisure	4,431	2.69
Retail	—	—

Table 5

ALIGNMENT OF NERC THEMATIC AND CORE STRATEGIC PROGRAMMES AGAINST NERC ENVIRONMENTAL FORESIGHT TOPICS

	£K	*% Science Budget*
Industry environment interactions	3,424	2.08
Environmental valuation	25	0.02
Land and soil use	2,805	1.70
Urban environment	1,283	0.78
Prediction of extreme atmospheric events	2,235	1.36
Mechanisms of climate change	25,970	15.77
Fluid dynamics in natural resource management	—	—
Coastal zone modelling and management	3,990	2.42
Structure and properties of the Earth's subsurface	18,711	11.36
Use of natural processes and materials	10,683	6.49
Sustainable use of marine resources	12,145	7.37
Ocean circulation	4,410	2.68
Remote data acquisition	9,478	5.75
Social and human health impacts of environmental change	1,453	0.88
Management of freshwater resources	7,451	4.52

QUESTION 2. DO YOU EXPECT TO SUPPORT A SIGNIFICANTLY DIFFERENT BALANCE OR SET OF PROGRAMMES IN FIVE YEARS TIME?

The NERC portfolio is currently the subject of a review with an interim report to Council due in September 1996. In terms of scientific programmes, this will encompass a review of the allocation of resources between ENRIs, modes of funding, science areas and the way in which these allocations address the 15 Environmental Foresight Topics (see Table 5) and 10 Scientific Challenges for the next five to 10 years, which have been identified through two extensive consultations carried out in 1995 (see *Environmental Directions* published by NERC in February 1996).

(a) *What areas do you expect will have increased support?*

NERC's input to the 1996 Forward Look of Government-Funded Science Engineering and Technology identifies a number of generic areas where increased emphasis is foreseen. These include:

- inter-disciplinary research aimed at understanding connections within the environment system, for example coupling of oceans, atmosphere and ice, and feedback between living and non living components;
- developing understanding and techniques to link processes at the level of individuals, local populations, or sampling areas to outcomes at the catchment, regional, continental or global scale and vice versa;
- greater integration between the natural and socio-economic sciences directed towards the application of basic knowledge of the environment to issues such as sustainability, environmental valuation and the development of decision support systems;
- early user involvement in the development of NERC programmes and partnerships in research and training including LINK programmes linked to Foresight priorities.

New thematic programmes selected by NERC for starts during 1996–97 and subsequent years include:

- Ecological Dynamics and Genes—bringing together population and molecular biology to address the spatial and temporal dynamics of ecological processes related to microbial diversity and function;
- Variability and Change in the Atmosphere—using sophisticated data assimilation techniques to derive maximum value from remotely sensed observations of the atmosphere from a range of current and planned satellite sensors;
- Micro-to-Macro Behaviour of Fluid-Rock Systems—providing the scientific foundation for assessing and managing rock-fluid systems for applications in the hydrocarbon, groundwater, mineral and waste isolation industries;
- Catchment Ecosystem Research Initiative—a large scale multi-disciplinary programme on river catchment ecosystems, linking river ecology, physical and chemical environmental science, socioeconomics and river management;
- Urban Regeneration and the Environment—developing understanding of the processes that cause environmental hazards and degradation in the urban environment and how these effects can be identified and mitigated or prevented.

Examples of new developments in core strategic research are:

- strengthening of the Earth Observation Science Initiative to train more scientists capable of applying information systems knowledge to environmental issues;
- a new programme on Clouds, Storms and Regional Meteorology concerned with the urban environment, air pollution, extreme winds and precipitation events and flooding;
- renewal of support to the Universities Global Atmospheric Modelling Programme for interdisciplinary research in atmospheric, coupled atmosphere-ocean and atmospheric chemistry modelling.

Other new initiatives include:

- a pilot scheme of a small number of interdisciplinary training awards spanning the natural and social sciences with a focus in 1996–97 on Environmental Valuation;
- extension of the NERC Research Fellowship scheme to include two new categories of Research Professor and Senior Fellow.

(b) *Which areas are likely to have their funding reduced?*

A number of thematic programmes started in the late 1980s and early 1990s are coming to an end. Major examples are:

- Terrestrial Initiative in Global Environmental Research (ends 1997–98);
- Land-Ocean Interaction Study (ends 1997–98);
- World Ocean Circulation Experiment observation phase (ends 1996–97).

Mapping of the currently agreed NERC programme over the next five years against the six ENRIs shows a clear reduction in NERC expenditure on global change research (in the terrestrial and marine areas), small declines in spend on natural resources and pollution and an increase in research on waste. This does not take account of the at present unpredictable future allocation of the headroom that will be created over the same five years for new initiatives.

(c) *What are the reasons for any expected change?*

The balance of programmes reflects the outcome of a critical examination of existing activities in terms of excellence and relevance to the NERC mission and consideration of new programmes in relation to the key scientific challenges and environmental foresight topics published in *Environmental Directions.*

Indicative planning allocations for the NERC Science Budget baseline suggest a decline in real-terms by some 4.9 per cent from 1995–96 to 1999–2000. Resources for new initiatives have to be found through redeployment of existing resources, through developing partnerships with users and other providers and through successful applications for new funding. Under the present funding regime it is not possible to support all new starts referred to above at the level that is warranted. There are also a number of other key activities that cannot at present be included in the forward programme.

External income for co-funding, contract research and, to a limited extent, sponsorship is an important input. Such funding is extremely difficult to forecast for more than a year in advance. A cautious forecast is for a continuation in the recent decline in income from other UK government departments and some levelling off or decline in funding from other sources.

QUESTION 3. WHAT PROPORTION OF YOUR BUDGET IS DEVOTED TO BASIC RESEARCH?

As noted in the answer to Question 1(b) NERC supports basic research and training through the non-thematic mode and alongside strategic/applied research within the thematic and core strategic modes. The response to this question relates only to basic research and training supported in the non-thematic mode.

Table 6

BASIC RESEARCH AND TRAINING SUPPORTED IN THE NON-THEMATIC MODE AS A PERCENTAGE OF NERC SCIENCE BUDGET (SB)

	Research Grants £m (% SB)	*Training Awards and Fellowships £m (% SB)*	*Total £m (% SB)*
1993–94 (actual)	15.0 (10.5)	12.0 (8.5)	27.0 (19)
1995–96 (planning)	18.3 (10.9)	12.6 (7.5)	30.9 (18.4)
1996–97 (planning)	19.9 (12.1)	13.4 (8.1)	33.3 (20.2)

Council has not yet taken a formal view on this level but it is unlikely that it would wish to see the 1996–97 figure of 20 per cent diminished.

QUESTION 4. BROADLY SPEAKING, HOW MUCH ALTERATION CAN YOU MAKE IN YOUR PROGRAMMES IN EACH YEAR?

The non-thematic mode of funding is re-cycled on a regular basis in line with the tenure of research grant awards, fellowships and training awards.

In addition, Council is continuing and further developing its policy of creating headroom within its baseline by:

- releasing funds as thematic programmes and activities come to an end;
- scrutinising core strategic and infrastructure activities which are being carried out within the Science Budget to ensure that they are still of the highest priority, that they are likely to deliver the required results and that they still need the allocation of funds previously authorised. Where appropriate, such activities are reduced or stopped and the funds released.

This process has identified headroom of £10.9 million over the next two financial years (1996–97 and 1997–98) and a further £32.3 million over the following two years (1998–99 and 1999–2000). Spread over the four years in question this represents the potential for redeploying 6.5 per cent of the Science Budget (2.6 per cent in 1996–97 rising to 11.8 per cent in 1999–2000). Much of the headroom for the next two financial years is already earmarked to provide for major uncertainties which Council might face in addition to possible new programme initiatives already in the pipeline, including a further phase of WOCE and a further tranche of LINK programmes. Only in the later years does the major part of the headroom become "free" for totally new initiatives.

This headroom is being created despite constraints caused by:

- Government ring fencing of some elements of the NERC budget (eg the British Antarctic Survey which accounts for 14 per cent of the 1996–97 Science Budget);
- Government initiatives such as ROPAs, Equipment and Foresight Challenge which impact on flexibility available to NERC Council and also drive wedges into the NERC baseline by not providing full funding for initiatives;
- high fixed costs in terms of infrastructure and salaries which cannot be reduced without prior investment, for example to meet the costs of further rationalisation.

QUESTION 5. WHAT MAJOR CHANGES IN PROGRAMME FUNDING HAVE OCCURED SINCE 1993 AND WHAT WERE THE REASONS FOR THEM?

The 1993 Government White Paper, *Realising Our Potential*, led to some changes in content and emphasis in the NERC mission.

The NERC budget was increased when, on 1 April 1994, NERC assumed full responsibility from SERC for Earth observation, atmospheric chemistry and science–based archaeology.

The following changes in process relating to funding and funding decisions have been or are being introduced to enable more effective delivery of the NERC mission:

- development of the new funding model (see introduction) and standardisation of peer review procedures across funding modes;
- opening up of NERC funding to a wider range of agencies—thematic mode opened up to Government Research Establishments (GREs), UK Charities and members of the Association of Independent Research and Technology Organisations with eligibility of ex–GREs decided on a programme basis; non thematic mode opened up to a range of academic analogues as well as universities with extension of eligibility to NERC Centres/Surveys also planned;
- development and application of a new methodology for assessing priorities for support in thematic and core strategic mode combining assessment of scientific excellence together with a range of other relevance criteria.

The development of partnerships in research and training both with users and other providers has been of increasing importance. Examples include:

- provision of additional support for partnership schemes with user communities, including LINK, introduction of the NERC scheme CONNECT, participation in the Teaching Company Scheme and increase in training partnerships (see also below);
- increased emphasis on early user involvement in programme development and on securing co–funding;
- launch in 1995 of an EPSRC/NERC waste and pollution management programme and of the NERC–University of Aberdeen Molecular Genetics in Ecology initiative.

Increasing concern over long–term career prospects has led to the development of a new four–stage Career Fellowship Scheme with opportunities for Research Fellows, Advanced Research Fellows, Senior Research Fellows and Research Professors. This Scheme will be implemented in 1996 together with a scheme targeted at returners to environmental science after a career break.

New thematic programme starts have included:

- Land–Ocean Interaction Study—to provide the scientific basis for the development of predictive models of the response of the economically important and fragile coastal zone to human activities and to natural changes (1993–97);
- British Mid–Ocean Ridge Research—studying geological, physical and biological processes at the mid–ocean ridges and contributing to international research on this recently discovered high temperature, high pressure environment (1993–98);
- Plankton Reactivity in the Marine Environment—to provide basic information on plankton processes needed to develop fully interactive models of the role of the ocean's biology in climate change (1994–98);
- Atmospheric Chemistry Studies in the Oceanic Environment—to provide an improved and quantitative understanding of the interactions of chemistry and transport in the troposphere in relation to climate change (1994–1999);
- Initiative in Taxonomy Research and Training (1993–98);
- Environmental Diagnostics—an interdisciplinary initiative focusing on waste management, bioremediation and land restoration (1995–2001).

In the non-thematic mode changes have included:

- a reduction in the overall success rate of research grant applications graded alpha from 54 per cent in 1992–93 to 30 per cent in 1994–95, despite the fact that the real value of funds available for such grants increased over the same period. Council's target is to maintain support at success levels at least equal to the 30 per cent level;
- NERC participation in the ROPAs scheme from 1995 with funding provision for new rounds up to 1998–99;
- the introduction in 1995 of five new Research Masters (MRes) training programmes;
- increased emphasis on NERC CASE and industrial CASE studentships (30 per cent of all NERC research studentships are now in partnership mode).

QUESTION 6. HOW DOES THE CURRENT SYSTEM FOR ALLOCATION OF THE SCIENCE BUDGET INVOLVING THE DGRC, COMPARE WITH THE PREVIOUS ONE WITH THE ABRC?

(a) *What are the strengths and weaknesses of the two systems?*

The ABRC system was more open to public scrutiny. For example the ABRC carried out a number of studies on strategic issues involving wide consultation and usually leading to the publication of reports. Their advice to Ministers was also published, at least in later years.

(b) *Is there any means by which the Heads of Research Councils can come to a common view?*

The Heads of Research Councils (HORCs) meet together monthly. These meetings provide the opportunity for discussing matters of common concern. The HORCs also meet together monthly with the DGRC as well as having bilateral meetings with him as required.

(c) *How can the scientific community make its views known to the DGRC?*

The scientific community is not known for being backward in making its views known. There are a number of channels it can use—direct to the DGRC, through the learned societies, through the Heads of Research Councils, through representations to MPs, through letters to the popular scientific press and other publications.

QUESTION 7. ON WHAT MATTERS WOULD YOU ROUTINELY CONSULT THE DGRC AND WHAT MATTERS WOULD YOU CONSIDER TO BE YOUR SOLE RESPONSIBILITY?

During the past year the NERC Chief Executive has had to seek the DGRC's permission for all appointments at UG5 and above (eg Institute Directors) and his endorsement for some of the Council's programmes. More generally, the DGRC offers plentiful advice on a wide range of aspects of management, organisation, scientific programmes and procedures.

QUESTION 8. HOW ARE THE VIEWS OF THE CONSTITUENCY IN EACH SUBJECT AREA IDENTIFIED AND TO WHAT EXTENT ARE THEY TAKEN INTO ACCOUNT?

There are a number of ways in which the views of the NERC science community and users are canvassed and through which these groups are represented in the NERC decision making process.

- Members of Council, the Science and Technology Boards (STBs), the Research Grants and Training Awards Committees (RGTACs), and Programme Steering Committees are selected partly because of the constituencies they represent.
- The science and user communities are invited to nominate members of Council, STBs and RGTACs.
- The STBs invite the views of their communities through open science meetings and user fora.
- The recent NERC survey of users and individual STB user surveys involve wide consultation; concordats and memoranda of understanding with Government departments and others contribute to knowledge of their policy needs.
- Regular meetings are held with a number of learned societies and disciplinary groups.
- Senior NERC staff pay frequent visits to universities and other groups within NERC's communities.
- NERC runs a number of "liaison groups" such as those on land use, air pollution effects research, and encourages ad hoc groups in other areas such as coastal resources.

- Consultations on specific issues, for example the development of the 10 Scientific Challenges included in *Environmental Directions* and the peer review process for determining programme priorities for the future sound out the views of NERC's constituency.

Question 9. What Arrangements do You Have for Consultation With the Higher Education Funding Councils? Is There Scope for Increased Co-operation with Them?

The main link is through Chief Executive's membership of the Science and Engineering Base Co-ordinating Committee chaired by the OST. Other links include:

- HEFCE Chief Executive meeting with Council members;
- NERC assessors on the appropriate Research Assessment Exercise (RAE) Panels;
- NERC representation on the Dual Support Transfer Review;
- NERC represented the Research Councils on the HEFCE/CVCP/SCOP Postgraduate Education and Training Working Party;
- informal discussions with HEFC officials and two-way exchange of information regarding initiatives/announcements etc.

There is scope for further interaction on matters such as the RAE and the mapping of RAE funding onto Technology Foresight; and on postgraduate funding, quality monitoring and assurance.

Question 10. Does The Availability Of Equipment Within Universities Cause Problems For You?

As far as "normal" equipment requests within individual research grant applications are concerned NERC has no particular problems. If the grant is awarded, any equipment requested is fully granted. NERC does, however, have difficulty in providing single equipment items costing more than £100-250k unless it can clearly be shown to be of benefit to a larger community that just the requesting department.

There continue to be genuine concerns over equipment status and continued capability in the academic community. The 1996 CVCP review of research equipment funding in HEIs gives details of equipment replacement costs and areas of particular difficulty. A shortfall of £395 million is identified in this review; this is virtually the same as an estimate in 1987. It should be noted that the review did not take account of the availability of national facilities such as those supported through NERC and other Research Councils. Further studies of the nature and extent of overlapping equipment and supporting needs may indicate that an extension of the concept of equipment-sharing and consortia arrangements is the best way forward in some instances.

NERC responded to earlier comments about the scope for increasing the level of equipment sharing by establishing or funding 19 specialist equipment centres—either pools of equipment for loan or well-founded laboratories open to applications from external scientists. Examples of the former are the Geophysical Equipment Pool (Edinburgh University); the Equipment Pool for Field Spectroscopy (Southampton University); and the Ocean Surface Current Radar Facility (Southampton University). Examples of specialist laboratories are the Isotope Geosciences Laboratory (BGS, Keyworth); the Mesosphere/Stratosphere/Troposphere Radar Facility (University of Wales, Aberystwyth); and the Radiocarbon Laboratory (Scottish Univerities Research Reactor Centre, East Kilbride).

NERC also supported its own Equipment Initiative in the late 1980s and early 1990s, providing special funding of £3.8 million over the period 1989-92. The scheme was terminated when applications declined from a high of 221 at the start of the scheme to just 35 in 1992.

The Joint Research Equipment Initiative (JREI) announced by OST this year will provide a further contribution. For 1996-97 NERC has allocated £650k to updated, upgrade and provide new equipment under competition A (for equipment up to £250k per item) and will advise HEFCE on the priorities for major equipment and facilities under competition B (for more expensive items). To-date nearly 50 requests for the JREI application forms have been received. Early signs are that potential applicants under Competition B are finding it difficult to attract and secure firm shared funding commitment from external sponsors and co-applicants.

Question 11. What Function Distinct From The Universities Do Your Research Institutes Have?

The particular functions of the NERC research institutes and laboratories are to undertake high quality strategic research, survey and monitoring which is long-term and large scale in nature, requiring continuity of support, provision of specialist infrastructure and, increasingly, a multidisciplinary team approach. Many NERC institutes are custodians of vitally important UK and international enivronmental databases which must be conserved for future exploitation in scientific research, policy development and industrial and commercial activities. Many also play a lead role in planning and facilitating UK contributions to international science programmes.

The institutes provide impartial, large-scale, interdisciplinary strategic knowledge about the environment. Delivery has to be at arms-length from government but in the public sector (to ensure impartiality); it has to be long-term (to document and understand slow, cumulative processes); and it has to be strategically driven (to ensure that emerging environmental issues and scientific opportunities are encompassed).

We believe that the continuity and strength of the underlying base provided by the institute structure cannot be guaranteed in universities, primarily because of their other major responsibilities (notably education and training). The independence of the research institutes also importantly allows the development of collaborative links and networks with other reseach providers (and users) as appropriate to particular issues and regardless of their affiliations.

Examination of Witnesses

PROFESSOR JOHN R KREBS FRS, Chief Executive, DR DAVID DREWRY, Director of Science and Technology, and DR RICHARD PAUL, Director of Policy and Communications, NERC, examined.

Chairman

1. Professor Krebs, may I first of all apologise to you personally because you have been upstaged, stood up or whatever, by this Committee on, I think, at least one and possibly more than one occasion. That you should be here with your colleagues on this particular day is very welcome. I am most grateful to you for having the patience that you have to allow us to invite you here. You know why we have invited you here. We are of a mind to enquire, as we have done in PPARC, into a second Research Council, that being your own which I am sure you regard as being a right and reasonable choice. In the questions that we propose to ask you we hope that this will allow not only us to be illuminated by what you have in mind doing but how we might shape our own inquiry, if you yourself want to be specific about where you think we should go and where it might be, I have to say, beneficial to your good selves. We will be very happy to have your advice on that matter. It has those two roles as far as we are concerned. We see your two colleagues. I know that Dr Paul has been very kind to colleagues on my Committee in Southampton, would that be right?

(*Dr Paul*) Yes, that is right.

2. I am so sorry I was not there myself. Dr Drewry, you are very welcome as well. Is there anything that you yourself want to say as an opening gambit or are we permitted to start our questioning?

(*Professor Krebs*) Thank you, Chairman. First of all, thank you for inviting us along. We are very pleased to be here. I could start off with a few words about NERC. I leave it very much up to you whether you would like me to.

3. A few minutes?

(*Professor Krebs*) Two or three minutes just to set the scene.

4. Why not.

(*Professor Krebs*) I am sure that much of this will be familiar to you in part, or maybe in total, but it might be helpful just to point to a few reminders. You will be aware, of course, that we are, as one of the seven Research Councils, the lead body for research, survey and monitoring of the environment and its resources. Our mission, as we summarise it in one sentence, is to promote knowledge, understanding and prediction of the environment and its resources. In fulfilling that mission we carry out and sponsor research, education and training, development of technologies, provision of facilities, curating and supplying environmental data—that is an important aspect of our mission—providing advice and expert witness to Government and other bodies, promoting technology transfer and promoting the public understanding of science. You will be aware that we have a budget of £165 million from the Office of Science and Technology and that our own establishments earn about another £40 million in externally funded research. Our own establishments account for about £80 million of our science budget money, £60 million is spent in universities. Over half of our investment in research is in our own establishments. The budgetary pie that we have can be sliced up in a number of ways. In terms of science we cover atmospheric science, marine science, earth science, terrestrial ecology, fresh water ecology, hydrology, polar science and earth observation. That is one way of slicing the budget. We also slice it in terms of six key issues that we have identified to drive our agenda, which are global change, natural resources, pollution, waste, biodiversity and environmental risks and hazards. Those are ways of thinking about our budget. I will just quickly summarise what I think our key contributions are in NERC. First of all, the excellence of our science and I just quote one indicator: in the last four years Britain has won three Craaford Prizes. As you know, the Craaford Prize is equivalent to the Nobel Prize but in areas for which the Nobel Committee does not normally award prizes. Three have come to the UK and all of those have been in the NERC area. The present Chief Scientist, Sir Robert May, was the most recent, two years ago Professor Nick Shackleton, an earth scientist from Cambridge, and the year before that Professor William Hamilton, a population biologist from Oxford were awarded the prize. That is the excellence of our science. Our science, of course, has a very strong role in underpinning issues of policy and issues of public good. You will all be aware of the work on the monitoring of the ozone hole in the stratosphere carried out at BAS and the work that was done in the NERC community to elucidate the effects of DDT in the food chain, to elucidate the impacts of acid rain, fall-out from

[**Chairman** *Cont*]

Chernobyl and other impacts of radionuclides in the environment and so on. Our science is also closely linked to industry, most obviously in areas related to mineral and hydrocarbon exploration in the British Geological Survey but increasingly, as all industries have environmental concerns and want to meet legislative standards and treat those as opportunities as well as costs, we have a very broad link with many sorts of industries. If I could just mention in the final points some special features of NERC as compared with the other Research Councils. I will mention three. One is the diversity of our user community. If you look at the National Technology Foresight Programme, all 15 panels had environmental matters in their agenda, so we do not look to one or two or three panels but to 15. The second special feature of NERC is the huge diversity of science that we are involved with, ranging from support for people in mathematics departments to people in molecular biology departments, people studying the atmosphere with space instruments, people studying the bottom of the ocean and below the bottom of the ocean through the Ocean Drilling Program. The third special feature of NERC is that we provide a one-stop-shop for all aspects of environmental knowledge and particularly environmental data. I will just end up by pointing to a few issues that are key issues on our plate at the moment that will be important for us in the next two or three years and beyond. The first of those is the Prior Options process, which you may wish to discuss later. The second is recognising that our budget, as with the other Research Councils, is stable at best and more likely declining in real terms. We have an increasingly sharp focus on prioritisation within our portfolio and trying to determine which are the top areas of science that we wish to invest in. In doing that we also want to try and create new areas of science, for example new technologies for exploring the environment, and also we feel there is an important area of linkage between our science and that of the ESRC. Another issue is lack of flexibility. We have a lot of major commitments in relatively fixed costs and we have little flexibility to renew our science. Finally, we have an issue of major investment in capital facilities like ships and aircraft and supercomputers. That is my brief summary, Chairman. I hope I did not go on too long.

5. I think you have already answered some of the questions, which is no bad thing. Thank you for that. Thank you for putting on the record in such a concise way the features of your Council which you think are most important to you and probably very interesting to us. I am going to ask a couple of much simpler questions. The first question I want to ask you is really about the structure within which you are operating. We are very conscious of the fact that there has been an entirely new template provided for Research Councils, how they are run, to whom they have direct responsibility, who chairs them, the staffing, the arrangements and all that. What I want to ask you first of all, therefore, is are you broadly satisfied with the new administrative structure for the Research Councils, including your own, which was introduced by Realising our Potential? Are there any areas in which you think it is proving difficult? Are there any areas in which you think it can be improved?

(*Professor Krebs*) Are we talking about the internal organisation of my own Council or the interface between my Council and the OST?

6. You can talk about any of those that you wish. We know that your internal structure has to some extent been determined by the OST proposal and we know that you have an interface with the OST and the DGRC and so on. It is really the structure within which you are currently being asked to operate which is largely as a result of the new changes imposed under Realising our Potential.

(*Professor Krebs*) If I could start, Chairman, with the internal structure within NERC and just say a few words about that. There has been a substantial change within NERC. We used to have, as I am sure you know, three science directorates which have now been changed to a single—

(In the absence of the Chairman, Dr Jeremy Bray was called to the Chair)

Dr Bray

7. May we open up a new question.

(*Professor Krebs*) Do you want to leave that question until the Chairman comes back?

8. Perhaps, yes. Looking forward what do you see as the key research opportunities before NERC in the next five years?

(*Professor Krebs*) We have attempted to identify key research areas by a major consultation exercise with our scientific community. We published earlier this year a little booklet called *Environmental Directions* which lists what we call ten scientific challenges. Rather than go through each of those—you are certainly welcome to have a copy of this if you do not have it already—what I will do is just pick out a couple of generic cross-cutting issues that relate to a number of these individual challenges. Those are, on the one hand, to deal with environmental matters at a range of scales. It is interesting that a lot of the experimental work in environmental sciences takes place on small scales in laboratories, for example studying atmospheric chemistry or studying population dynamics of beetles, but the questions that one wants to address in the longer term operate on a very large scale, for example global change in climate or global changes in biodiversity. This issue of how you translate across spatial scales is a major challenge for my community. Another major challenge is one that I have already mentioned which is to link the natural sciences of the environment with economic and social sciences.

9. In the latter do you have arrangements for working with the ESRC?

(*Professor Krebs*) We keep in very close touch. I meet with Ron Amann regularly. We have a number of different joint initiatives under discussion in, for example, the area of environmental evaluation: how do you put a value on environmental capital? This is a key issue for discussions on sustainability. We launched a new programme in the area of the urban

[**Dr Bray** *Cont*]

environment which is closely linked to the ESRC programme on urban social systems, and indeed an EPSRC programme on the built environment.

Mrs Campbell

10. Professor Krebs, I wonder if I could just ask you about the LINK and ROPA programmes. I wonder if you can see these as being useful in that they bring in extra money into research, into areas that you would want to have covered anyway, or are they in fact proving to be a major constraint in the way that you do your work?

(*Professor Krebs*) LINK and ROPA in their different ways are both very interesting and useful mechanisms for stimulating connections between science and users. We have traditionally not been heavily involved in LINK programmes but within the last two years have started six new LINK programmes, one in earth observation, one in aquaculture, one in hydrocarbon reservoirs, one in marine sensors. Dr Drewry will mention the other two.

(*Dr Drewry*) Biological treatment of soil and water; we have also got a share in horticulture and genetic and environmental aspects of health.

(*Professor Krebs*) So we have actually become much more involved in LINK than we have been in the past which I think answers your question by deed, saying that yes we do find it a useful mechanism as part of our overall portfolio. With ROPAs we are involved at a level that is somewhat below that of BBSRC, EPSRC and MRC but we have a portfolio of about £4 million worth of ROPA grants. I would say what I have seen of the ROPA initiative is that it has tended to elicit responses from a certain part of our community, which is probably not surprising since the entry ticket, as you know, is 25K in any one year from industry for generic research. The part of our community that is most likely to have that sort of support is the earth science community because of their strong connections into both the hard and soft minerals industry. I think one danger of these mechanisms is that they may inadvertently perturb the balance of our portfolio by favouring certain areas over others. For those sorts of reasons I am very happy to be involved but I think they should be just a part, probably at about the present level, of our portfolio. It is not something that I want to dramatically increase.

11. If I could ask a supplementary to that. The ROPAs are being sold as a mechanism for getting more money into basic research but is it true, in fact, that that is what they are actually achieving? Would you describe it as basic research?

(*Professor Krebs*) I think the research that we are funding through the ROPA mechanism is strategic rather than really blue skies but perhaps I could ask Dr Drewry for a comment on that.

(*Dr Drewry*) What we are doing is looking at the rules of the ROPAs and applying them fairly stringently. The proposers of the projects, once they have passed the £25,000 mark, can promote any form of basic or strategic research. What we are not looking at is anything near market or applied. Essentially we are going for those that we can judge are the highest quality.

(The Chairman returned to the Chair)

Mr Batiste

12. On the ROPAs you are satisfied that the ROPAs are producing high quality work, they are being used in very high quality projects?

(*Dr Drewry*) We are as satisfied as we can be given the type of peer review mechanism that goes into the ROPA scheme. We see the projects come in, we provide advice and feedback to try to bring up those we feel are maybe somewhat weaker. In fact, there are ROPAs that we reject outright because they are sufficiently insubstantial not to warrant money from NERC. We work within the constraints of the review system.

Chairman

13. I gather you tackled another question but you are coming back now to the answer to question one, would that be right?

(*Professor Krebs*) If the previous question has been answered.

Chairman: Mr Miller, do you want to come in first?

Mr Miller

14. In determining your research priorities, particularly in the context of projects where there are international collaborations, how do you interface with departments like the ODA? In particular I am interested in the fact that you referred to the earth science field.

(*Professor Krebs*) Yes.

15. If there are projects competing for the same sum of money that on the one hand is in the interests of a mineral exploitation programme and the other is a volcanology project to protect the people of Montserrat, how in practical terms do you determine priorities particularly in the context of developing nations?

(*Professor Krebs*) I would like to give three separate strands to my answer and then perhaps ask Dr Drewry and Dr Paul if they have any other comments. The first point to make is that in what we call non-thematic mode, which is purely responsive mode, individual projects are judged entirely on their scientific merit. This pot of money is 20 per cent of our budget. In the thematic mode we develop programmes. A programme is a collection of projects; it may contain 20 or 30 or as many as 90 projects in some of the larger programmes. The individual projects are judged principally on scientific merit. The overall value of the programme as a whole is judged on a mixture of scientific quality, it has to be above a certain scientific level, but also on its potential relevance, which can be measured in a number of different ways. I think the answer to your question has to depend on whether you are talking about individual projects or a whole programme. If you are talking about a whole programme, if we were

[**Mr Miller** *Cont*]

judging between a programme that deals with an issue in a developing country versus a programme that deals with an issue in the UK we would, among other things, look at the scientific quality and look at the information and feedback that we get from our user community about the potential benefits derived from the programme. Amongst our users are, of course, ODA, they are a major customer and user of NERC research, so they would have a say. Coming to my final point, I think there is a substantive issue about whether the White Paper in its emphasis on wealth creation and quality of life in the UK has to a degree down-played the importance of research that underpins the development of other countries. Clearly that is a major aspect of our interaction with the ODA, carrying out research in developing countries that improves their wealth and their quality of life.

Chairman

16. You were about to answer when we were rudely interrupted by the bell what view you have about the existing structure both inside NERC and between NERC and OST and whether you had any views about its improvement or its adaptability.

(*Professor Krebs*) The changes within NERC were brought about through my own initiative and not "instruction" from OST. I perceived that NERC could be better suited to meet new challenges with a new structure. That is why that change came about. I could elaborate on that if you would like me to.

17. That was something that was your initiative. Did it have to be in any way approved by OST?

(*Professor Krebs*) When I was interviewed for the job of Chief Executive of NERC I was asked by the then Chief Scientific Advisor what my vision for the organisation of NERC would be and I showed an overhead which essentially laid out the structure that I have since implemented.

18. They were aware?

(*Professor Krebs*) They were aware of it but I did not seek approval for it. I said that is what I was going to do.

Mr Batiste

19. On that point we have been told you actually need the DGRC's permission for senior appointments. Has that ever been a problem for you?

(*Professor Krebs*) Let me come on to that. That was the new structure as it was set up when I arrived in NERC. We then moved on into a phase where the senior management review was being conducted. This I believe, was initiated by Treasury but then cascaded out to other government departments and non-departmental public bodies. During that period, which lasted for about a year altogether, there was, in effect, a freeze imposed by OST on senior appointments, so we had to delay a number of senior appointments, heads of institutes, whilst the management review was in place. Now this has been completed, the remaining vacancies have been advertised. Two directorships are going to be filled within the next month, the Institute of Hydrology and the Institute of Virology and Environmental Microbiology. I would say there was a temporary pause associated with the senior management review.

20. Just to get that right; the problem was whether financially you could advertise those appointments and make an appointment, not a question of a continuing issue of, "Now the funds are available for the appointments you have to seek the consent of the DGRC for the appointments you make"?

(*Professor Krebs*) It was the former. It was whilst the senior management review was in process the DGRC felt it prudent for research councils not to make appointments at and above the grades that were being scrutinised.

Chairman

21. That was not peculiar to you. That was across the board.

(*Professor Krebs*) Across the board, right.

Sir Trevor Skeet

22. Can I ask one question here. You mentioned that you cover the 15 separate panels, you range over a very very broad area and your commitments are very high indeed. Do you feel that the balance is correct between you and the other research councils?

(*Professor Krebs*) The balance of investment by OST?

23. Yes.

(*Professor Krebs*) I would always argue that NERC should have a bit bigger slice of the cake but my fellow Chief Executives would equally argue in another direction.

24. I do not think you have got my point. I was concerned about the boundaries between yourselves and the rest of the research councils. Are you happy with these bearing in mind your commitments?

(*Professor Krebs*) I think however you divide up the cake there are going to be boundary issues. I could point to half a dozen areas which are boundary areas which could be in NERC or could be in another research council. For example, there is the interface between agriculture and the environment which is split between BBSRC and NERC. There is the interface between marine technology and oceanography. Marine technology is in EPSRC but we develop instruments and sensors to explore the oceans. I think the important point is that we maintain very close dialogues with our sister research councils to ensure that on the one hand things do not fall between the gaps and on the other hand when we mount new programmes or develop new initiatives we do it in full dialogue and full awareness of what each other is doing. For example, last year we launched a programme on waste and pollution management jointly with EPSRC because we were both interested in the same area, EPSRC mainly concentrating on the engineering aspects and NERC on the environmental impacts of waste and pollution. That is going to happen however you slice up the cake. The important thing is to make it work and not to get anxious about what is in a particular individual's territory.

Chairman

25. Can I bring you back to the commentary on the internal structure and we had this point about recruitment being under control. Carry on on this question of the structure.

(*Professor Krebs*) As you know, the reporting line is that I report within NERC to my Council and to my Chairman. Within OST there is a reporting line to Sir John Cadogan, the DGRC who is charged in the White Paper with the duty of "looking across the piste", as he calls it, of the six (now seven) research councils and advising Ministers on the balance of the programmes and on the delivery of the programmes by the different councils. In my accounting officer role I report to the Permanent Secretary now in DTI (originally in OPS, as it was). In his role as Director-General Sir John clearly has an interest in looking closely at all the research councils' programmes and discussing in detail with the Chief Executives their plans for the coming years and what they have delivered in the past years. After the initial evolution, let us say, and getting to understand the new system, I think the system is now working well.

Chairman: Thank you for that. That takes us then to customer contactor. Spencer Batiste?

Mr Batiste

26. We are looking at the area of the customer/contractor relationship and in particular your relationship with the Department of the Environment which is your largest public sector customer. It has the commitment to competitive tendering with you. Is this the main way in which you get your work from the Department of the Environment and, if so, do you feel something is being lost through the process taking place in this way as opposed to more traditional methods?

(*Professor Krebs*) I will start off and then I will ask Dr Paul to make some comments because in his area of NERC he deals with concordats. I think there are two kinds of relationship that we have with DoE and with our other principal customer departments (ODA, MAFF and MoD). The two kinds of relationships are first at the level of individual scientists within our establishments talking to individual budget holders within DoE about contracts for particular pieces of work. That proceeds in, I believe, a reasonably satisfactory way. I think some of our scientists would wish the government departments, for example the DoE, to take a slightly longer-term view and support things in a, say, three to five year cycle as opposed to a one to two year cycle.

27. Do you feel the problem now over the length of term that is taken is a consequence of the general political funding cycle or more to the effect that there are not necessarily now the skills within the departments themselves necessary for appreciating the scientific issues that may be involved?

(*Professor Krebs*) I think the budget holders in the government departments are very keen to identify the deliverables, the outcomes, of the research and that sometimes in more speculative longer-term research the deliverables are a little less clear than they are in short-term work. Let me turn to the second level of interaction which is under the umbrella of the concordats on which Dr Paul leads for NERC. The concordats are the umbrella under which we carry out longer term more strategic looks at departmental scientific needs in relation to our own investment in science. The flavour of those discussions which occur in, for example, strategy fora is for us to say to the policy department and Chief Scientist groups, "Gaze into your crystal ball and tell us not about your policy needs this year and next but what you think are the up and coming issues in five years' time and beyond. We are not asking for money, we are simply asking for guidance. We would like to use that guidance to invest our own science budget money to position us to be able to be well placed to answer policy questions that you will then wish to purchase from us in five or ten years' time." That sort of dialogue is very helpful, and leads on occasions to co-funding of longer-term programmes. The thematic programmes that I referred to earlier on, which are five-year programmes, are sometimes co-funded with government departments because we have been able through this dialogue to identify longer-term needs.

28. Given the reductions that there have been in manpower across the Civil Service and in many of the major departments, do you consider that there is sufficient skill remaining within the departments to act as an informed customer with you or do you have to take a much stronger lead in trying to identify the scientific uses for the department?

(*Dr Paul*) With the DoE I do not think I have noticed any particular weakening of customer expertise. Much of the concordat discussions take place with the Chief Scientist's group in DoE and they are very well informed about what their needs are.

Chairman

29. Presumably they give you the right kind of briefing which would enable you to provide the answers as best you can?

(*Dr Paul*) Yes. We have a very good working relationship with DoE.

Dr Jones

30. Does your contracting process affect your ability to secure adequately skilled staff? What are the staffing arrangements?

(*Professor Krebs*) One thing one would say is that increasingly the contracts at the individual scientist level have become smaller and more fragmented and that does pose a challenge to our own establishments to maintain continuity of careers for young scientists. I must say, I admire my directors and their staff for their ability to perform incredible feats of juggling to keep people in post over many years on a large number of short contracts. This is a challenge and I think the Centres and Surveys rise very well to it.

31. Does that make effective use of their resources though if they are having to organise those kinds of arrangements?

[Dr Jones *Cont*]

(*Professor Krebs*) It means that a lot of time is put into gathering many contracts: a complaint that I hear from them is that they spend a large amount of time chasing contracts. Whether it is a waste of resources is a matter of debate, but it is certainly a time-consuming activity. To come to a second point about our staff arrangements; we have approximately one quarter of our staff on fixed-term appointments which are usually for three years and three quarters are on open-ended appointments. The fixed-term appointment staff tend to be at the younger end of the spectrum, and are often the most dynamic as science is inherently something that suits the young mind. We do have the issue of maintaining the staff who are on fixed-term appointments who are often the seed corn for the future. What we have recently done is to set in place a framework for our younger staff which asks our centres and surveys to consider after five years of a fixed-term appointment whether they wish to retain an individual on an open-ended appointment or give that individual a signal that he or she is not going to have a place in the future and therefore they should leave; in other words, we are trying not to keep people indefinitely on short-term appointments.

Chairman: It will not surprise you, Professor Krebs, that with 27 per cent and more of your expenditure being on climate change we have a number of questions on that field.

Dr Bray

32. The Intergovernmental Panel on Climate Change came up with a fairly mammoth review paper recently with a very strong conclusion that the balance of evidence suggests that there is a discernable human influence on the global climate. The normal peer review processes in science tend just to grow rather than to be created by external authority. The practices and the general proceedings of the Royal Society are not decreed by any external authority. The IPCC, on the other hand, seems to have been created by the UNEP and the World Meteorological Organisation. Does it command the authority putting independent peer review?

(*Professor Krebs*) I am not sure I am well placed to answer that. I think what I can say from the UK perspective is that the scientific evidence is assessed by IPCC and the scientists who do the assessing are highly respected members of the scientific community. So as to whether it has scientific street cred or not, I would say the answer is largely yes.

33. Is it not really rather extraordinary that so wide ranging a review could have been undertaken in the way that it was in reaching such a clear conclusion?

(*Professor Krebs*) It is extraordinary and I think the amount of care and iteration that went into the final drafting of the words is something that reflects that extraordinary process. I do not know whether Dr Drewry wishes to add anything on this.

(*Dr Drewry*) I think one would have to look at the process by which any review would be undertaken: who would be competent to review the IPCC report given that it has engaged so many of the outstanding world players in the field. Several hundred scientists came together to produce the various studies that form the chapters of the IPCC final report. Those were then sent out to many hundreds of other scientists for technical comment which you might consider to be a form of peer review, although it was not strictly laid down according to the rules of international scientific journals. So the number of scientists that have been involved in expressing their ideas about the process really has soaked up all of the intelligent comment that could be made.

34. Is this a dangerous position in terms of critical judgment of the future development in this very important area?

(*Professor Krebs*) My view is that it is a process by which a consensus on scientific issues can be reached. I guess one of the problems is it is difficult to express minority opinions under this process. There will be issues and questions that lie at the margins or the core of the problem. This process does not expose those in a way in which it can then frame tomorrow's big headline questions. On the other hand, it does provide us with a snapshot of views from a fully international high level scientific perspective.

35. And there are no current proposals for changing that process?

(*Professor Krebs*) I do not believe so.

Sir Trevor Skeet

36. International bodies have been slanted towards global change and I see there is an advisory panel of the Coordinating Committee of the World Climate Programme and they have established a climate agenda. Are these treated by the NERC and the DoE as being operational proposals?

(*Professor Krebs*) I think the views that come forward from international groups such as the World Climate Research Programme and IGBP are certainly inputs into our own strategic thinking and vice-versa. As you know, for the UK as a whole there is a single co-ordinating body for global change research called the Inter-Agency Committee on Global Environmental Change at which NERC, the other Research Councils, DoE, the Met Office and BNSC represented, as are the other key players. So I think the United Kingdom has a very well co-ordinated view on needs for global environmental research. You also almost certainly know that we recently in the Inter-Agency Committee commissioned a United Kingdom national strategy that was prepared by Professor Brian Hoskins, an atmospheric scientist from Reading, with the advice of a committee that contained a unique and interesting mixture of physical scientists: oceanographers; atmospheric physicists and chemists; biological scientists; physiologists and so on, and economic and social scientists. It was the first time that a group of that diversity had been brought together to look in a coherent way at the needs of the United Kingdom, in the context of what everybody else is doing, for research in this area. It is a very helpful general steer for all the research councils especially NERC.

37. Professor, these are very important bodies and they seem to have a co-ordinated opinion but how are they financed and how are they managed?

(*Professor Krebs*) Do you mean the international bodies?

[Sir Trevor Skeet *Cont*]

38. Yes, the international bodies. Do you have to subscribe an annual subscription or do you leave it to some other source?

(*Dr Drewry*) If I may answer this question. For instance, the International Geosphere Biosphere Programme is part of the International Council of Scientific Union's activities. The United Kingdom through the Royal Society pays a subscription to ICSU and ICSU then sets up a number of co-ordinating bodies which it has deemed to be appropriate such as IGBP. The framework of the science that IGBP wishes to undertake is generated and then it is up to national organisations like NERC to support programmes that are congruent and fit with some of those large headlines.

Dr Bray

39. You are suggesting that NERC does not have any money for research?

(*Dr Drewry*) No, ICSU and IGBP are simply setting an agenda.

40. Is it really satisfactory to have a system by which the learned societies and the peer groups outline the programme but the funding is left to an uncontrollable process of independent agencies working nationally?

(*Dr Drewry*) You have to look at the converse: whether you want to have some sort of monolithic structure which is global and which tries to then fund programmes. You have a mini version of that in a sense in the Framework Programmes in the European Union. One has to ask are these being effective in hitting the key areas of science within Europe or within a global context.

41. Answering your question, there could only be one answer and that is that in the programme as it is worked out on review from the intergovernmental panel on planning programmes on the climate agenda and cognate programmes, that relying on peer review to do the planning is a very much better way of doing it than relying on governments to do it. Is that your statement?

(*Dr Drewry*) Certainly you have to get the scientists involved and use the processes with which scientists are familiar, which includes peer review. It also means exposure at large international meetings where issues can be debated in the real cut and thrust of a scientific forum: out of that process should come your agenda. It should not be that the science is set by a body some distance away from the science unless it has a policy steer to it.

Chairman

42. Can I just be clear that whilst this sounds as if the whole thing is being managed by mirrors you are satisfied that what you are doing is actually co-ordinating and producing a very clear steer for the scientific endeavour that you want to happen. Is that right? You are not worried about this?

(*Professor Krebs*) I think the international co-ordinating programmes like the World Climate Research Programme and IGBP provide us with a useful context within which to view our own priorities.

43. And you rely on that?

(*Professor Krebs*) We use it as part of our information. It is important, I think, for global research problems to have a degree of cross talk between the major nations. For example, the initiative of taking a snapshot in time of the world's ocean circulation (the so-called World Ocean Circulation Experiment) is something that requires the co-ordinated efforts of a large number of nations including the United Kingdom. You need to have some sort of body that helps with that co-ordination. That is the role I see for bodies like the World Climate Research Programme and IGBP. They are to help each national body to understand what the others are up to and to provide co-ordination. To go beyond that, we need to ask whether as a result of the co-ordination, genuine added value emerges. That is an important question and one that we do ask.

Sir Trevor Skeet

44. Could you just follow on there. About 28 per cent of your budget is concerned with global change which seems to be quite considerable. How much of this is related to these international models? Can you apportion it?

(*Professor Krebs*) Yes, it is related in the sense that we determine our own priorities of what we want to mount by way of programmes but we look at those priorities in relation to the thinking of these international programmes. So a common pattern is for the international programme to set a broad area of interest and then for NERC as a national funding agency to look at whether its own priorities fit within a broad area of interest. To take one example, the terrestrial environment, carbon flux—the world's carbon budget and the contribution of the terrestrial environment to the carbon budget—is an area of global interest. Everybody thinks that that is important. We mounted our own programme to tackle the issues that we thought were important within that general area aware that other countries were doing parallel research.

Dr Bray

45. In terms of the budgetary commitment to doing work are the internal figures in the Met Office, Julian Hunt and in the Department of Environment, David Fisk, and who is the equivalent person in NERC?

(*Professor Krebs*) Sorry, say that again.

46. The key characters in delivering the budgetary implementation of national programmes in the United Kingdom are Julian Hunt, Director-General of the Met Office who has the Hadley Centre as almost a part of his empire (who was, incidentally, technical advisor to the advisory panel which drafted the climate agenda internationally) on the one hand and on the other hand the Chief Scientist of the Department of the Environment, David Fisk. Those are very clear foci of responsibility. Is there an equivalent focus in NERC?

(*Professor Krebs*) The focus for delivering the science portfolio as a whole is Dr Drewry. Individual programmes within that portfolio are managed by

[**Dr Bray** *Cont*]

programme managers who are in the scientific community and who have a steering committee to which they report.

Chairman

47. There is not actually a single individual in NERC on this?

(*Professor Krebs*) We do not have a Director of Global Change.

Dr Jones

48. You mentioned a few moments ago, Professor Krebs, that there was a United Kingdom national strategy on climate change. Taking on board the points you made earlier about the needs of developing countries, is that taken into account in the national strategy and what should the balance be between research into the global effects of climate change and dealing with local problems related to it and also the balance between the actual investigation of the nature of the changes and developing measures that will ameliorate or adapt to those changes?

(*Professor Krebs*) There are three questions there I think. One was local versus global. Then does the UK strategy look at impacts—

49. They are related; obviously global will affect local.

(*Professor Krebs*) There is identifying the processes and trying to ameliorate them or anticipate them. Local versus global: clearly they are interconnected. If you talk about the climate of the United Kingdom in the future (What is our world going to be like? Is it going to be hotter, cooler wetter, dryer?) that depends on processes that are occurring all over the surface of the globe. A major deliverer of heat to the United Kingdom, as you know, is the Atlantic Ocean. It delivers 27,000 times our total national industrial power output so it is a major source of heat for us. The circulation that brings heat to what would otherwise be a frozen region is partly determined by currents off the coast of South Africa and South America and so on, so you cannot really disaggregate the local and the global. Of course, what government and what industry want to know is predictions, not just for the UK but for bits of the UK. If you ask Yorkshire Water what they would like to know, what they want to know is if it is going to be dry in Yorkshire over the next five years.

50. That is a problem of water privatisation maybe.

(*Professor Krebs*) There is a need for fine scale prediction but to achieve that fine scale prediction we need global models. It is difficult to disaggregate them. I think inevitably there is a focus in the fine scale modelling to look at the issues that affect Northern Europe more than perhaps the issues that might be fine scale issues in Southern Africa. That would be a focus of our programmes.

Dr Bray

51. The bit of global modelling which you are specifically responsible for is the oceans.

(*Professor Krebs*) And atmosphere.

52. The atmosphere is primarily modeled by the Met Office and the Hadley Centre. Nobody else is doing the oceans other than your own programmes.

(*Professor Krebs*) We are obviously integrated with the Hadley Centre. There are ocean models going in to their global climate models. You are not quite right to say that the Hadley Centre is the only group doing the global atmosphere. There are actually two global circulation models in the UK. There is the Hadley Centre model, which is a grid point model, and there is the ECMRWF, the European Centre for Medium Range Weather Forecasting model, which is a spectral model. The spectral model was originally developed by Brian Hoskins of Reading and that is a model which is used by the university community mainly supported by NERC, so we do both atmospheric and oceanography modelling.

53. On the ocean side there is nobody other than NERC.

(*Professor Krebs*) That is correct.

54. And you have to be the operational as well as the research arm in this on problems like, say, are the eddies which are identifiable in a smaller scale in the fine structure modelling important in the global transfers. At present my understanding is that the Hadley Centre are not persuaded that they are and NERC thinks that in fact they are. Does this not require something like the intensity of effort and, if you like, the command structure, the discipline in the oceans area that exists in the meteorological atmosphere area by means of having to produce the weather forecasts?

(*Professor Krebs*) I think the business of producing an operational forecast for the oceans is not actually NERC's job. Our job is to provide the underpinning science that might in the long term deliver an operational service. Whether we should have a "wet office" akin to the Met Office is an interesting question, but if we did it would not be NERC's job to provide the wet office.

55. Whose job would it be?

(*Professor Krebs*) That is a very good question. I think that is an issue that the government would have to decide, whether it is MoD, as in the case of the Met Office, or whether it is DoE.

Dr Jones

56. Could we allow Professor Krebs to finish answering my question, please.

(*Professor Krebs*) Just a footnote to Dr Bray's question; in terms of co-ordinated effort in the underpinning physical oceanography, of course that is NERC's role and we have a very clear co-ordinated view about what we need, what we currently support and what we are likely to support in the future in the area of physical oceanography. That is largely done at the Southampton Oceanography Centre, which I believe you visited recently, but also, particularly in the coastal area, at the Proudman Oceanographic

[Dr Jones *Cont*]

Laboratory. Now I come back to your second question about the processes versus amelioration. I think policies to ameliorate have to be built on a firm understanding of the processes. The big areas of uncertainty in global climate change are the numerous feedbacks that occur. We know from simple physics of the atmosphere that if the CO^2 level goes up that is likely to cause warming because the CO^2 acts as a blanket. Warming is going to lead to more evaporation, more clouds. Does more cloud mean a further blanket and therefore even more warming or does it actually mean less warming because the clouds act as a shield to prevent the sun's rays hitting the earth's surface? We do not really know for certain whether that increasing cloud cover is going to produce a positive or a negative feedback. Similarly, we do not know whether warming up the soil is going to produce a positive feedback by releasing more carbon. I will just show you a picture. This is an experiment that we have recently done in the north of England of warming up peat soils. As you warm up the soil the water flowing out of the soil goes from this colour to that colour. Why does it go from light to dark? It is because warming up the soil releases dissolved organic carbon into the water. Eventually that carbon comes out into the atmosphere. So if you warm up the soil by half a degree you may release the many gigatonnes of carbon that are stored in the soil and produce a positive feedback. It is these kinds of feedbacks that we do not understand. Without understanding them it is hard to set in place the right kinds of policies and mechanisms to reduce the impacts.

57. Is that what it means for developing countries?

(*Professor Krebs*) The same is true for developing countries. We need to know exactly what the causes are and what the effects are and then we can look into how to prevent them.

Mr Batiste

58. Whilst we are still on this subject I wonder if I could ask whether you have any plans to use the information on solar emissions and its impact on the earth's atmosphere that was going to be produced by the Cluster launch that was aborted on the Ariane rocket and, if you were, have you made any representations either to PPARC or to ESA about a replacement programme?

(*Dr Drewry*) The one part of NERC which did have a principal investigator status with the Cluster Mission was the British Antarctic Survey. Their work on the ionosphere, operating out of the Antarctic, was going to be complemented by a programme with the Cluster experiment. That has been terminated and I guess they will be making representations. I know they are very active in trying to pursue this, but I cannot tell you precisely whether that representation has been particularly strong.

59. If it goes ahead at all it will be on the basis of the mission spare and three small satellites. Will that still give you the information that you were needing for your purposes?

(*Dr Drewry*) The mission was originally determined as an optimum process in order to have the satellites moving through the magnetosphere. I cannot give you a technical answer to the question, but I guess that there will be a loss of information against the original programme but maybe sufficient results to start making some preliminary models of the interaction between the magnetosphere and the ionosphere.

Mr Miller

60. I am still not entirely clear about the customer/contractor relationship in the context of climate change. Are departments like the Foreign Office, the ODA and particularly the Ministry of Defence net contributors to the project or net beneficiaries from the research? How are their contributions determined in the context of the international scope of projects?

(*Professor Krebs*) If you look at the UK total investment in global environmental change research, NERC invests about £45 million, which is by far and away bigger than any other research council, it is about six times all the other research councils added up together. If you look at who are the other players, BNSC, which is part of the DTI, through its space programme, invests about £53 million and DoE and MAFF between them invest about another £50 million in global change research. Their work is much closer to policy requirements than the work that we support on the underpinning science and the basic processes. So if you ask the question whether DoE and other departments contribute or benefit from our programmes, I would say there is a bit of both. They contribute, but they also benefit because of the synergy between our science base investment and their more applied work.

Mrs Campbell

61. I think this may be a question which has already been partially answered, but there are various bodies with responsibilities for research into climate change. There are yourselves, the Met Office and the Department of the Environment, and I wonder how you co-ordinate that research and whether you make sure that there are not any gaps and that nothing falls in between.

(*Professor Krebs*) I think we have partly answered this, but just to go over that in a little bit more detail, the Inter-Agency Committee serves as the co-ordinating body. One of the tables in the Hoskins Report is a "Who does what?" table. It describes what are the major areas of focus of the different sponsors of global change research. That table could in fact be used to look for gaps, but I think it is more useful in identifying areas of opportunity rather than gaps. It does point to areas where additional investment by one or more of the sponsors could lead to great benefit, particularly in the inter-relationship between the human dimension and in the natural sciences of the environment.

Dr Jones

62. It has been suggested to us that there has been a reduction in the atmospheric research with the Met Office no longer carrying out very much research itself, fundamental research, and that with the work

[Dr Jones *Cont*]
carried out in universities, the universities feel that because of the financial pressures upon your organisation, it is easy to reduce funding to universities than to your own institute. Is there any validity in those complaints?

(*Professor Krebs*) Needless to say, this is something I have heard about from the atmospheric science community. I think there are two points here. First of all, it is true that the Met Office is moving to a trading fund status, but it is equally true that they are not, at least so Julian Hunt tells me, decreasing the number of research scientists that they employ.

63. It is fundamental research though.

(*Professor Krebs*) Well, whether the research shifts to more near-market remains to be seen. I have certainly been very aware of that possibility and have been in discussion with Julian Hunt about the possible responsibility that would fall on to NERC's shoulders if indeed the Met Office did move away from more basic underpinning research, and I have argued that if we were to accept that responsibility, we would welcome it, but it would require some additional resources. That has been my position. More generally though, what we have done in the last year with our university community is to develop the concept that there should be a dispersed centre for atmospheric science and technology, not a physical entity. This Centre for Atmospheric Science and Technology (CAST), should serve to co-ordinate the activities of the NERC university communities, the Met Office and any other bodies that are involved in atmospheric research. With CAST in place, we would have a co-ordinated focus and we would have a view from a single (dispersed) organisation about what the UK needs were. On the particular point as to whether we are cutting funding for atmospheric science, the answer to that is clearly no. In the process of turnover of our programmes, two major—

64. You say "clearly", but that reminds me of what politicians say, "Our policies are clear", and they usually are not.

(*Professor Krebs*) Well, let me explain what I mean. In the natural turnover of programmes, two major atmospheric science programmes are due to come to an end in 1998 and 1999. One of them is Laboratory Studies of Atmospheric Chemistry and the other is called Interactions between the Chemistry of the Atmosphere and the Oceans. We are expecting the atmospheric science community to propose new programmes that could in principle develop what is going on in these existing programmes.

Chairman: Could we turn now to the role of the scientific advice which is a very broad area.

Dr Bray

65. You have moved yourselves to having a structure to focus your own particular science to the centres and you have just mentioned the Centre for Atmospheric Science. There used to be a quite strong activity in oceanography with John Woods which was changed by the restructuring. Has experience since then made you consider whether some move back to the previous position might be possible?

(*Professor Krebs*) No.

66. You think that whereas the atmosphere needs the Centre, the oceans do not?

(*Professor Krebs*) Well, the oceans have. For deep-sea oceanography we have a very large centre, the Southampton Oceanography Centre, which is, as you know, jointly sponsored by NERC and the University of Southampton.

67. What about when it comes to giving policy advice? In an example like Brent Spar, and so on, it does require accessibility by ministers and government and so on, but at the same time the independent integrity of science. Is that adequately provided for at present?

(*Professor Krebs*) I think that is a key point. In the NERC area, because there are many sensitive policy issues on which independent authoritative advice is required, it is important that we have authoritative scientists on tap that we can turn to. Traditionally, those scientists have been the scientists in our own establishments because they, in the nature of things, being our own employees, are immediately responsive to questions that we put to them. Whether in the longer run the Southampton Oceanography Centre will continue to provide that degree of responsiveness is an issue on which the jury is still out. At the moment they are still very responsive to us. John Shepherd, who, as you know, chaired the inquiry into the decommissioning of oil platforms such as the Brent Spar, used some of the staff of the Southampton Oceanography Centre in the inquiry and that grouping was very responsive to the needs of NERC. But I think we will have to wait and see if, in the longer term, that responsiveness will remain.

68. Even operationally in the case of the Brent Spar, the Department of Trade and Industry did not, as the first port of call, come to NERC, but they went to the Scottish Office.

(*Professor Krebs*) Yes, they did in the initial inquiry.

69. Whose scope was very much narrower, its competence was narrower than that of NERC.

(*Professor Krebs*) Yes.

Chairman

70. I think we have also seen the difficulties, to put it mildly, with the BSE issue and now we have had another statement today about the possibility of sheep and transfer and that kind of thing. Science as a whole would appear to have found it difficult at least to get their case accepted.

(*Professor Krebs*) I do not want to get too deeply into BSE.

71. No, I do not think we do.

(*Professor Krebs*) In brief, I think the difficulty with BSE is that the scientific knowledge that would provide a clear steer is simply not there. We do not know what the agent is, we do not know how it is transmitted and, therefore, the scientists cannot give authoritative statements on the risk. I think an important goal for me as Chief Executive of NERC is to ensure that the scientific strengths are there in order to meet requirements for answers to ploicy questions in the environmental sphere.

Mrs Campbell

72. I just wonder how much you see it as your role to alert politicians to possible crises, even though you may not have solutions to them? We saw in the case of BSE, of course, that produced tremendous problems and I suppose, putting it another way round, would you consider hiding something from politicians if you felt you did not have the answer?

(*Professor Krebs*) That had never occurred to me.

Sir Trevor Skeet: Of course not!

Dr Jones

73. Not drawing their attention to it because we do not read the scientific literature that often.

(*Professor Krebs*) I will ask Dr Paul to come in on this because it is really his area. Part of our programme of public understanding of science that we have been pursuing very actively in the last two years is to ensure that our scientific information comes to the attention of people such as yourselves who are in positions to influence policy, as well as decision makers in industry. We have been very pro-active in promoting our knowledge in that direction. I do not know whether you would like to add anything, Dr Paul?

(*Dr Paul*) I think to answer the question, if we were aware of a scientific issue that was going to lead to a policy problem down the line, of course we would draw it to somebody's attention.

74. What are the mechanisms though?

(*Dr Paul*) For example, we could arrange a briefing session for the part of Government that was most relevant to the particular problem.

Mrs Campbell

75. The problem is that if you cannot suggest a solution, because you do not know yourselves, that is when it causes politicians worse difficulty.

(*Dr Paul*) Yes.

76. Or maybe it allows them to use you as scapegoats.

(*Dr Paul*) We try and be very careful when we do these briefing sessions that we are focusing on the science which is what our community is expert about. They can fulfil the role of expert witness. It would not be for them to tell Government what its policy should be.

Dr Jones

77. What would you do if it was ignored?

(*Dr Paul*) Try again.

Chairman: Well done for that, Dr Paul, that must be the right answer.

Dr Bray

78. Would you consider that any Member of Parliament had the right of access to any NERC establishment to ask any member of staff any question he or she wished?

(*Professor Krebs*) In general, yes, one should have access to the scientist to ask them as individuals, or one should be able to ask for what we call loosely the NERC view, which is no more than an aggregate of the views of the scientists that we have consulted and drawn together.

79. That is a distinct position from the departmental laboratories where for example ministers have offered to accompany opposition spokesmen to departmental laboratories?

(*Professor Krebs*) Yes. We have discussed in our council within the last three months what our position should be on offering advice, expert witness, etc.. We have had robust inputs from the members of our council who are central Government department chief scientists and others. The view we have come to is that individual members of our staff should be free to offer expert witness or opinion or advice on matters where they feel competent to do so. They should make it clear in what capacity they are offering that advice. Certainly at the level of individual scientists we would not wish to have any form of constraint or gagging. There may be occasions such as when we are asked to answer a PQ or provide input to a Select Committee in which NERC centrally, draws together expert witness, advice and opinion. In that case, as I have just said, we draw together the views of our own establishment scientists and the university community. That is one of Dr Paul's jobs, to draw together those views and offer input.

Chairman

80. Can I take that a little further and discuss your institutes and research councils and Prior Options. Do you believe that Research Council Institutes could be or possibly should be treated in the same way as departmental research establishments? Might there be benefits in removing the Institutes from NERC control?

(*Professor Krebs*) I think we have to recognise that they are very different beasts from departmental research establishments. On the whole, Research Council Institutes are carrying out basic and strategic research. There is not a lot of historical record to go on to look at what the consequences of changing the ownership arrangements or perhaps privatising that kind of establishment might be.

81. Has the Prior Options process become a bit too open and threatened efficiency and morale perhaps in some of the institutions under review?

(*Professor Krebs*) I could say that our scientists are punch drunk with review. They are reviewed over and over again. As you know, the Prior Options review followed directly from the PSRE scrutiny. A number of our establishments were also reviewed in the years preceding that scrutiny. For example, the British Geological Survey underwent a major review at Cabinet level in the late 1980s which led to the establishment of the BGS core programme. I think there is a sense of *deja vu* amongst our scientists. I am always impressed and amazed by their determination to get on with the job. I spend a lot of time, of course, going around and talking to my staff and they do show a high degree of resilience under this continual barrage of questioning and review.

[Chairman *Cont*]

Chairman: They are keenly getting on with the job but they are fed up, is that right? Okay, we will leave that unsaid.

Sir Trevor Skeet

82. Professor, there are many ways of dealing with the Prior Options. We went down fairly recently to the Southampton Oceanography Centre and were very impressed with your £48 million building there and all the facilities within it but we did note the solution, NERC has gone in with the local body there to deal with the situation. It seems to be an ideal solution to go to a local university. Could we not adopt this in other fields as well?

(*Professor Krebs*) There are three points I would make. First of all, the Southampton Oceanography Centre clearly has the potential to be the world's leading oceanography centre. It is up there with the Scripps Institution in California and the Woods Hole Institution on Cape Cod. It is one of the three biggest oceanography institutions in the world. That is a tremendous benefit. It cost a lot of money to get there, you said it was £48 million to put up the building. We had to move a lot of staff there and that cost us additional money. These things do not come cheap. I think the question that we still have to wait and see the answer to is how SOC will develop in relation to the requirements of the NERC mission. It is a big experiment. As a scientist I say it is not a very good experiment because we do not have good control but it is an experiment nevertheless. There is an element of "wait and see" how the Centre develops.

83. Professor, can I put a second point to you, you mentioned in your opening remarks that you won three of the Craaford Prizes, for which I congratulate you, that is very impressive, on the other hand you did mention that you have a lot of major commitments to undertake and some of these initiatives are very expensive. Are you not too big as an Institution and would you not benefit if you hived off, we will say, the British Geological Survey?

(*Professor Krebs*) I think the solution you propose is not necessarily the answer to our problem. We have a large amount of long term commitment. Some of this is in essentially ring-fenced activity such as the British Antarctic Survey, which is £25 million in round terms. The British Geological Survey is slightly more loosely ring fenced but that amounts to about £12 million in the core programme. If the British Geological Survey, for example, were separated from NERC and owned by somebody else, in that ownership transfer the new owners would wish us to make a long term commitment and would negotiate very hard for this. If we look in other government research establishments where contractorisation or other forms of privatisation have been undertaken, the typical model is that there is a five to seven-year commitment by the sponsor department. So I do not think that this solution would give us greater flexibility. I think the way we would achieve greater flexibility would be through a degree of rationalisation. We have a large number of sites and we could, by rationalising sites, reduce our overhead and our running costs and, therefore, generate greater flexibility.

84. Professor, you probably recollect a report, the Butler Report, a few years ago which looked into this question of whether they should be sheered off and I think they came to a positive recommendation. Would that not be an advantage to you and then you would be able to spread your money and concentrate it on the fields where you have got these important initiatives and take it away from a body that wants to be independent?

(*Professor Krebs*) Well, first of all, as I have just said, if the BGS were hived off, I do not think that that would free up resources because I think the resources would be tied to the BGS. I think it is the wrong solution or the wrong answer to the problem. I think the disadvantage of separation of the BGS from NERC is that at the moment we provide an integrated environmental capacity and that many of our programmes cut across not just our own establishments, but cut across the establishments and the university sector. Just to take one example in BGS. At the moment part of BGS is co-located and integrated with the Institute of Hydrology. That is the BGS Hydrogeology Group which deals with groundwater, whereas IH deals with surface water. If BGS were separated off from the rest of NERC, we would then possibly have to recreate a hydrogeology group associated with the Institute of Hydrology. So there are important synergies that run across our establishments. I have just given you one illustration, but I could have given you many others.

Mr Miller

85. I start by saying that many years ago I was a recipient of monies from the BGS through working for colleagues in Portsmouth and at that time it was quite common to see BGS work in parallel, alongside and in partnership with industrial concerns, particularly in the field of civil engineering and engineering geology, but it is quite clear that some of the data collected by BGS is a highly marketable product. What impacts do you think it would have on those less marketable aspects of BGS if the Government were to decide to privatise those bits that are commercially valuable?

(*Professor Krebs*) I am very much against fragmentation, of cherry-picking of profitable bits. I think you are right to point to the data, not just the data in BGS, but the data that NERC holds in general, as a very valuable resource. It is a resource that is valuable for the public good. Often we want to ask questions about our earth resources, about the atmosphere, about our water resources, and often the data to answer those questions for the public good resides within NERC. I think that it is key that they should remain in the public domain. In terms of commercial exploitation, all the NERC data centres have a remit to look for opportunities to exploit their data commercially as well as for the public good and for research. BGS, for example, as you may know, has been in partnership with the insurance industry to develop the so-called Geohazard Assessment Package, GHASP, which you can use by going up to a keyboard of a PC and tapping in your postcode and immediately you get a listing of all the geohazards that affect your house. It can be quite frightening depending on where you live. You can see the

[Mr Miller *Cont*]

commercial value of this to estate agents, to the insurance industry, to house purchasers and so on. So they do exploit data. I believe we can do more and we are always trying to do more as we develop our policy on that. Another point about the BGS and other databases is that whilst they are in the public domain, private sector interests will contribute to the database. This is particularly true of BGS where some of the major minerals and hydrocarbon industries supply data and put it in the BGS database because it is publicly-owned and publicly-held.

86. Are you satisfied that the private sector is playing absolutely with a straight bat in that, particularly in the context of new areas of oil exploration and gas?

(*Professor Krebs*) What do you mean by "playing with a straight bat"?

87. Is information that should be put into the public domain getting into the public domain? Is there a proper trade of data in that sense?

(*Professor Krebs*) I think I would not wish to give a detailed answer to that without going to check at BGS, I do not know.

Dr Jones

88. Could we have a follow up on that?

(*Professor Krebs*) Yes.

Chairman

89. Perhaps you will drop us a note on that?

(*Professor Krebs*) Yes.

Dr Jones

90. You know probably that we have just finished an inquiry into PPARC and one of the major headaches was the impact of the LHC on their budgets. I do not think you have anything as big as that but how do you cope with large scale capital investments? Are there any problems ahead?

(*Professor Krebs*) We have a number of major capital facilities for the UK, particularly ships and aircraft. We are involved also in some international programmes. The largest one in terms of subscription is the Ocean Drilling Programme which is obviously much smaller than CERN but still substantial. In terms of capital provision, the issue will be in the future: "How does a science budget which is not increasing in real terms set aside the money to invest in new infrastructure?" It is not a problem unique to NERC, it is a problem for the whole science base. Paul Williams, the Director of CLRC, is very concerned about how in five to ten years' time he will be able to replace the synchrotron radiation source at Daresbury. We are concerned equally how in about five to ten years' time, when these things will become critical, we will replace our research vessels. The research vessel that is next in line for replacement is one of the antarctic vessels, the RRS Bransfield, which is a supply ship. At the moment through the British Antarctic Survey we are looking at a whole range of possibilities from PFI to leasing to buying a second-hand vessel, etc. More generally for research vessels my vision is that the way in which we will achieve a good capability in the future is through European collaboration. I signed a trilateral agreement, the first of its kind, with my counterparts in France and Germany in February of this year which has set in place the arrangements for sharing our fleets on a co-ordinated basis such that in ten or fifteen years' time, in principle, there could be a single fleet of vessels shared between European countries, which I think is a more affordable aspiration than for each country to have its own research vessels.

Chairman

91. This allows me actually to follow up with a question about utilisation because there was some POST assessment which indicated that a lot of the NERC earth science grants committee has not funded any ship time for two and a half years in this country. Are you sure that you are utilising the ships adequately and on your present system of a day to day basis of costing, are things being well managed in that regard?

(*Professor Krebs*) May I ask Dr Drewry to answer that?

(*Dr Drewry*) The research vessels' fleet is geared up to be responsive to the appropriate applications from the scientific community, whether they are from universities or whether they come through some of our programmes that require vessel support. We look at those very much on whether the quality of the science itself has justified research money and then whether the research vessel requirements that they look for can be delivered. We have three ocean-going research vessels. They are not geared up individually to do all marine science and, therefore, sometimes we do get inappropriate applications. Also you can only deploy one ship at one time in one place and, therefore, there is quite a competition as to what sciences to support. Priority is again judged against the quality of the science.

92. Are you saying that it may be frequently the case that vessels are not utilised because the science does not fit to the specifications of the vessel, for example, and they are tied up for a long time?

(*Dr Drewry*) Sometimes particular pieces of science may not be able to be supported by the vessels and their fit of equipment. In those cases we quite often, through the arrangements that Professor Krebs has already indicated, go to some of our European and indeed North American partners to assist.

93. One assumes that you will seek to endeavour to have the vessels actually profitably deployed in that way.

(*Professor Krebs*) I think the key facts are that the demand is always in excess of supply. There are high quality, unfunded science programmes which would like to use our vessels, but we are not using the vessels to the maximum capacity. In round terms, a vessel can be at sea for 90 per cent of the year and it has to be in dock being scraped down and cleaned up for 10 per cent. We are actually able to deploy the vessels for 70 per cent of the time because we do not have enough money to pay for the other 20 per cent.

94. So the vessel itself could be deployed usefully for up to 90 per cent, you say, of a whole year?

[**Chairman** *Cont*]

(*Professor Krebs*) Yes, and we are using it for 70 per cent. What I have asked the Director of the Research Vessel Service to do is this: I have asked him to look for possibilities for commercial use of the vessels out of which he will make enough profit to fund more science use. Of the 20 per cent unused capacity I have asked him to look, say, to get 10 per cent of that for commercial charter and to make from that enough money to fund the other 10 per cent for science.

Sir Trevor Skeet

95. On the other hand, Professor, there are quite a number of anomalies. Southampton Oceanography Centre charges full port fees, even though that Centre leased the quay 125 years ago. Is that not a complete absurdity and why, as a public institution, do you tolerate this?

(*Professor Krebs*) It has leased the site on a 125-year lease starting from 1988 or 1989. I think the fees at the Southampton dock are high.

96. Yes.

(*Professor Krebs*) They are higher than they were at Barry which is the former site of the Research Vessel Service and it is in the objectives of the Director of the Research Vessel Service, Dr Charles Fay, to negotiate those port fees down. I believe we should not be paying a higher fee than we were at Barry, although I recognise that Southampton is a more expensive place.

Chairman: He is going to be a busy man, Dr Fay.

Dr Jones

97. Those projects, the high quality projects, you said which are not being funded, would you put them as a higher priority than, say, the schemes that are funded through ROPA or any of the other top-sliced schemes?

(*Professor Krebs*) In terms of Alpha scoring, you know, the Alpha system, there are some Alpha 4 science projects in the use of ships that are not funded, so the cut-off point is sometimes as high as Alpha 4. In the first round of ROPAs, we did not score things on science quality because that was the instruction, but in the most recent round we have scored on science quality and I think I am right in saying that we have not funded in the ROPA scheme anything that is much below Alpha 4. So in pure science quality, there is not a lot to choose, given that there is a certain fuzziness in the scoring system. A more general question might be where do the Council's priorities lie. The Council did take a strategic decision last year not to invest more resources in marine science in order to fully fund the use of the research fleet. A request came from our recent Marine Science Board for additional resources and the Council put that as a lower priority than some of its other initiatives but, of course, in that list ROPAs were not represented because ROPAs came from outwith the Council.

Chairman: Thank you, Professor Krebs, you have completed the answers to the questions we have given. We are most grateful both for your presence and for your co-operation. That goes too for Dr Drewry and Dr Paul, we are very grateful. Thank you very much.

Memorandum submitted by Professor John Krebs, FRS, Chief Executive of the Natural Environment Research Council (2.10.96)

With reference to your letter of 31 July, I attach an additional note which addresses the supplementary questions raised by the Committee following our oral evidence session in July.

Also enclosed is a copy of the National Strategy for Global Environmental Research produced for the Inter-Agency Committee on Global Environmental Change (IACGEC) by an Expert Panel under the chairmanship of Professor Brian Hoskins. This Strategy was launched at a meeting at the British Association for the Advancement of Science on 10 September. In addition to co-ordination through the IACGEC, NERC also holds regular bilateral meetings with the other Research Councils (including ESRC] and with Governmental Departments, at which issues concerning global change are discussed alongside other areas of common interest. Such meetings provide policy level opportunities for exploring each other's particular concerns and considering the potential for joint working. Opportunities for collaboration also come up through researchers from different communities talking to each other and submitting joint or complementary proposals through their funding systems.

Finally I enclose, as requested, a copy of the transparency that I showed to the Commmittee on the results of warming of peat soils. This comes from work carried out by scientists at the NERC Institute of Terrestrial Ecology as part of the TIGER programme (Terrestrial Initiative in Global Environmental Research).

SUPPLEMENTARY INFORMATION PROVIDED BY NERC

1. Percentage Success Rate for ROPA Awards

1.1 NERC participated in the ROPA scheme for the first time in 1995. There have been two rounds to-date.

	ROPA 95	*ROPA 96*
Number of awards	38	18
Value of awards	£3.4m	£1.4m
Success rate by value	53%	21%
Success rate by number	59%	25%

1.2 Similar data for the success of non-thematic research grant applications (standard and small research grants) are as follows:

	Non thematic grants 1994/95	*Non thematic grants 1995/96*
Number of awards	201	202
Value of awards	£13.96m	£14.44m
Success rate by value	19%	21%
Success rate by number	23%	23%

1.3 It is not appropriate to make direct comparisons between the success of these two types of support since the assessment systems are different.

— Non thematic grants are subject to full external peer review of science quality and are graded as a result of that peer review. Only a percentage of those grants achieving alpha grades can be supported.

— ROPA proposals, strictly speaking, only need to cross the barriers of being "novel and technically feasible" to attract funding. Applications to the 1995 round were reviewed by a NERC Panel but not subject to full external peer review. In 1996 the Panel did have the benefit of the results of a limited external peer review. In addition, a stronger line was adopted towards proposals outwith the spirit of being highly speculative, proof of concept approaches: proposals akin to what would be expected to be submitted through the normal non-thematic grant application system were not supported. All applications which passed these hurdles received support.

2. Senior Management Review and Senior Appointments

Appointments

2.1 It has never been the practice for OST to be represented on appointment boards for senior NERC posts (other than for the Chief Executive and Chairman).

2.2 During the Senior Management Review, OST placed an embargo on all Grade 5 replacements. This has now been removed. Proposals for **new** posts at this Grade and above still need to be approved by OST but this is not a **new** requirement.

Senior Management Review

2.3 The Review recommended the loss of one Grade 5 post at Swindon Office and one at the British Geological Survey. The case for retaining another post at BGS was to be looked at again after the outcome of Prior Options, and all posts in the senior structure were to have their grading confirmed by formal job evaluation with a requirement for external quality control of this evaluation.

2.4 The timescale for implementing the reduction of the two posts already identified is mid-1997 for the Swindon Office post and 31 March 1997 for the BGS post.

3. CLUSTER

Background

3.1 NERC involvement is through the British Antarctic Survey (BAS). Dr Richard Horne has co-investigator status on the WAVE experiment consortium; this provides access to data from other experiments on the mission which would then be available to other BAS scientists via collaboration.

3.2 The primary purpose of the BAS involvement is to study electrodynamic micro-turbulence and how this leads to the development of magnetic storms. Magnetic storms are known to affect satellites, communications and power lines. The aim was to make co-ordinated measurements between the source region (using CLUSTER) and the ionosphere above the Antarctic where magnetic storms effects are particularly severe (using radars and specialist radio receivers). This was to be combined with computer modelling at BAS.

Impact of the loss of CLUSTER

3.3 The unique feature of the CLUSTER mission was that by having four identical spacecraft in close proximity, space and time ambiguities could be resolved (for example to determine the motion and electrodynamics of three dimensional structures in space). With the loss of CLUSTER, the BAS scientists will not have three dimensional data in source region to combine with Antarctic measurements or use in computer models. Single point spacecraft measurements have been made before but are not sufficient.

3.4 BAS scientists have provided scientific input to discussions on a CLUSTER re-fly mission and several options are under consideration by the CLUSTER Principal Investigators and the European Space Agency. As far as BAS is concerned, a replacement mission comprising four spacecraft with essentially the same instrument suite and on-orbit capability remains the highest priority; there is no sensible alternative to obtain the data they need on micro-turbulence. Thus, until such time as a CLUSTER type mission is flown, this particular BAS project will be shelved and the staff effort will be directed onto other high priority solar-terrestrial physics topics.

3.5 Recognising that the loss of the CLUSTER mission has had a serious impact on a large number of other UK scientists, BAS has indicated that it would welcome requests from research colleagues who were originally expecting to exploit the CLUSTER data to have access, on a collaborative basis, to the extensive BAS archive of data which has been collected from a range of ground-based sensors and also, with certain restrictions, to data from the NASA/ESA/ISAS multi-spacecraft ISTP programme on which Dr John Dudeney (BAS) is a Principal Investigator. Whilst these data sets in no way replace CLUSTER, they do provide valuable source material for a range of solar-terrestrial physics research.

4. GLOBAL CLIMATE CHANGE—INTERNATIONAL COLLABORATION AND AVOIDANCE OF DUPLICATION

4.1 International collaboration is vital to successful research into global climate change. The sheer scale of the task demands a pooling of human and technical resources. Although it is important to ensure efficient use of scientific effort through the avoidance of unnecessary duplication, some duplication will be appropriate to validate results and ensure a climate of competition.

4.2 NERC and NERC supported scientists are fully involved in international collaboration, which can take place at or between several different levels: individual project to individual project with little or no funding agency involvement; national programme to national programme; individual project or national programme to EU programme; national programme to global programme; EU programme to global programme.

National programme to national programme

4.3 At any agency level the International Group of Funding Agencies (IGFA) for Global Change Research is an informal partnership of national funding agencies which exchanges information on national programmes, discusses approaches to integration, promotes co-ordination of access to specialised facilities, and aims to optimise national contributions to global change research. NERC is a member of IGFA. There are also many other direct programme links. At the multilateral level the European Climate Support Network and at the bilateral level the collaboration between the NERC supported Land Ocean Interaction System (LOIS) programme and the French programme on coastal zone research (PNOC) are good examples.

Projects/national programmes to EU programmes

4.4 The Framework programme gives high priority to global change research and, through its funding, provides a powerful incentive for researchers to expand existing co-operations and develop new ones. There are instances of partnership arrangements between the EU and particular national programmes, for example the stratospheric ozone campaigns EASOE and SESAME which involved over 60 European research teams and was co-ordinated from a Unit based at the British Antarctic Survey. In addition, EU concertation programmes in areas such as TERI (terrestrial research) and ELOISE (coastal zone research) provide foci for European co-operation and, through association with national programme contributions to international programmes, such as the NERC supported programmes Terrestrial Initiative in Global Environmental Research (TIGER) and LOIS, for wider international co-operation.

National programme to global programme

4.5 So far as global change research is concerned the major international programmes, in particular those pursued under the umbrellas of the International Geosphere-Biosphere Programme (IGBP) and the World Climate Research Programme, continue to dominate the international scene. With the exception of the Ocean Drilling Program these programmes depend on the co-ordination of national programmes rather than the long-term commitment to shared facilities. The objectives for the international programmes create a framework for research within which national contributions can be developed. The UK has strong, yet selective, involvement in the scientific leadership and implementation of these programmes. In the UK the case for support of national programme contributions is always considered alongside other claims against the research budget, and takes account of the quality of the science and the capability of the UK to make a significant contribution.

4.6 An example using the World Ocean Circulation Experiment (WOCE) may help illustrate the point. The first phase of WOCE is now coming to an end. Since 1990 the international effort has involved a spend of over $1 billion with different countries collaborating in observations of the global ocean from ships and satellites, in many places for the first time. The focus is now moving to data synthesis and interpretation and the international science community has developed a plan for a five year Analysis, Interpretation, Modelling and Synthesis (AIMS) phase to run from 1997–2002. Following extensive discussion, the UK oceanographic community has developed proposals for a UK contribution to AIMS. This targets areas of national priority where the UK has particular expertise and can make a strong contribution to the international objectives. The proposal has been submitted to NERC and will be refereed and considered against competing claims for funding later this year. A copy of the UK AIMS plan has been placed on World Wide Web and is thus available also to readers worldwide.

EU programme to global programme

4.7 The EU has to-date played a limited but useful role in facilitating conferences and workshops in association with the IGBP. There are plans for developing the activities of the European Network on Global Change Research (ENRICH), which is supported through contributions from EU research programmes on Environment and Climate, Marine Science and Technology and Co-operation with Third Countries and International Organisations. The objectives are: to improve research co-operation within and between the EU, states associated with the EU, central and Eastern European states, the newly independent state of the former Soviet Union and developing countries; to assist the development of research co-operation all over the world; and to promote activities liable to contribute to international programmes. The aims are to build on existing research initiatives and focus on development of networking and co-operative links, exchange of data and information, capacity building to address regional implications of global change and policy analysis of those changes, identifying research gaps, and contributions to formulation of the international science agenda.

5. Commercial Use of Nerc Research Vessels

5.1 The NERC research vessels have been chartered to non-NERC organisations and commercial companies for a number of years. The additional income goes towards reducing overhead costs of the seagoing support for NERC's marine science programmes.

5.2 The potential market for these specialised research ships is limited and customers are confined, in general, to those who wish to use the ships for scientific research and survey, for example Government Departments, foreign marine research organisations and more recently on behalf of the hydrocarbons industry.

5.3 The charges to non-NERC customers are always greater than those to NERC scientists. Each commercial charter is negotiated on an individual basis in relation to: what the current market will bear; and the uniqueness of the facility being required (eg Multibeam Echo Sounder). The excess of income over expenditure is re-invested in the service to NERC science through provision of new scientific equipment and/or reduced costs.

5.4 During 1996–97 the Research Vessel Services is more than likely to achieve its target of chartering ten per cent of its ship capacity to the commercial market.

6. Private Sector Inputs to Nerc Databases

6.1 As requested by the Committee, the following response majors on private sector data held in the National Geosciences Information Service (NGIS) at the British Geological Survey (BGS) but also includes information on the situation at other NERC Designated Data Centres excluding the Antarctic Environmental Data Centre).

British Geological Survey

6.2 Onshore Data (UK landmass out to 12 mile limit offshore)

Legal requirements—under the Mining Industry Act 1926 and the Water Resources Act 1991 there are requirements for copies of logs from boreholes of over 30 metres drilled for the exploration of minerals and over 15 metres for water to be deposited with BGS. Notification of drilling operations also has to be provided and BGS given the opportunity to sample from the borehole if they wish to do so. (The Mining Industry Act as amended by the Petroleum (Production) Act 1934 defines petroleum as a mineral.)

Voluntary deposits—some 40-50,000 logs are also deposited voluntarily each year by, for example, site investigation companies.

Quid pro quo deposits—a small amount of private sector data is deposited voluntarily but subject to receiving a quid pro quo from BGS in terms of waiving certain charges in relation to other data sales or services. These arrangements are subject to periodic review.

Exchange of data—some private sector data comes through agreements on data exchange.

Restrictions on release:—some of the data comes with no restrictions; some is classified for a specified time; some is classified in perpetuity. Much of the latter is historical data and if the donor is known a release date is sought; the aim is to avoid such restrictions in the future and to agree a reasonable release date for all data deposited, mindful of any commercial considerations.

The NGIS has shown that it can manage geological data holdings economically. Many in the private sector see it as cheaper to lodge copies of their data with NGIS and to put back copies of the data as and when needed, rather than to retain copies themselves.

6.3 Offshore data

There are no legal requirements on the oil companies to lodge their borehole data with BGS. Rather the Petroleum (Production) Regulations make it a condition of granting a licence for the licence holder to provide copies of the exploration data (borehole and seismic) to the Secretary of State for Trade and Industry. It is for the Secretary of State, if he so chooses, to make the borehole data available to BGS. He has not so chosen until the data is released from confidentiality, ie six years after its deposit. There is no agreed period for the release of seismic data.

When BGS was operating the core store for the Department of Trade and Industry (DTI), BGS staff had pre-sight of the borehole and seismic data deposited, but only those working on DTI contracts could actually use it until the formal release from confidentiality.

It is not clear why DTI will not recognise the role of NGIS as the national repository and thus furnish copies of their geoscience data holdings from the outset. However it has recently been agreed with DTI officials that copies of the borehole data catalogue will be provided. This shows the sampling location and owner. It will then be for BGS to write to the owner if it wishes to access or have copies of the data.

British Atmospheric Data Centre (BADC)

6.4 The BADC does not hold private sector data to any extent. Apart from NERC generated data it has quite large holdings of meteorological data from the Meteorological Office and from the European Centre for Medium Range Weather Forecasting. There are a number of restrictions associated with these data, the two main ones being that they should be disseminated for research purposes only and that, in some cases, the data are classified for a short time until they fall outside the relevant forecasting period. Large amounts of data from NASA are held but these are all public datasets with no restrictions apart from acknowledgement of the source.

British Oceanographic Data Centre (BODC)

6.5 With the exception of oil companies, private sector involvement in collecting oceanographic data away from the coastal zone tends to be minimal—the vast majority of data are collected by government funded organisations (including NERC, MOD, Fisheries Laboratories) and by universities.

6.6 In the 1980s BODC had close ties with the UK Offshore Operators Association (UKOOA) and were responsible for assembling a comprehensive databank of the data buoy, weathership and oil rig data collected on behalf of (or pooled with) UKOOA. Data held were primarily environmental rather than resource orientated. BODC was responsible for liaising closely with the private sub-contractors involved in collecting the data to ensure quality. The data were generally restricted for a period of five years after which time they became freely available. The restriction was aimed primarily at preventing access to companies not prepared to subscribe to UKOOA funds. In general bona fide scientists were allowed free access provided permission was first sought from UKOOA. During the same period BODC was also responsible for rescuing oceanographic data collected by Offshore Environmental Science Ltd. when the company was forced to close down.

6.7 There is not now the same involvement with oil companies as there was in the 1980s. Involvement with other private sector data has also been minimal. There have been occasional offers of private sector data to BODC but these have not been linked with the funding needed to assemble/package the data for use by third parties and they have therefore usually been declined.

6.8 One of the tasks of the National Co-ordinator for Marine Environmental Data, appointed recently under the auspices of the Interagency Committee on Marine Science and Technology and hosted at BODC, will be to investigate what data are held in the private sector. At present only a simple and far from complete directory is available.

Environmental Information Centre—Biological Records Centre (BRC)

6.9 The BRC receives data from national biological societies and specialist groups. No significant difficulties have been experienced with these suppliers putting constraints upon use. This is because the BRC is co-funded by the Joint Nature Conservation Committee and is seen as being part of the broad conservation community. There is some control over access to sensitive data on rare/threatened species but data with unreasonable constraints on use/access are not accepted.

National Water Archive (NWA)

6.10 On the surface water side the private companies only provide a tiny proportion of the national archives. Mean daily flow records come from the environmental agencies which collect most of the data themselves and receive records from those few stations still operated by private water companies. Groundwater levels data on the national archive are similarly collected almost exclusively by the environmental agencies. Large numbers of wells and boreholes are privately owned and can only be monitored by consent; access permissions are a sensitive issue in a minority of cases. Again the data feed into the environmental agencies. All these data are indexed or published in the Hydrological Yearbook UK.

6.11 Twelve private water companies provide monthly reservoir statistics which are published in a collated form in the Monthly Hydrological Summary of Great Britain. In addition two companies provide their full water situation reports, including water supply statistics but no move has yet been made to agree publication of a sample set of water demand values from them.

6.12 Other interactions with private companies include an agreement under the LOIS programme with Yorkshire Water for the free supply of their sewage effluent discharge data, for internal use only with no explicit publication of figures; successful collaboration with the Soil Survey at Silsoe (now private as part of Cranfield University) for work on the production of the Hydrology of Soil Types national dataset.

6.13 The private water companies collect a mass of operational data from telemetry systems or automated laboratories, for proving to their regulators that all is well. This is not seen by the NWA although some, albeit probably only a small percentage, could be valuable to environmental scientists.

NERC Scientific Services Data Centre

6.14 The majority of remotely sensed data held within the NERC Archives are acquired by the NERC aircraft or received directly by the Dundee Satellite Receiving Station.

6.15 However about one third of the data in the Archives are "private sector" or commercial satellite data purchased for use in the NERC-funded science community. Whilst in global or European terms the Archives are not capturing the majority of the commercial satellite data, they are the major non-commercial repositories in the UK and a first enquiry point for UK academics. The quality of the data is excellent. In general copyright regulations restrict access to the commercial satellite data to the NERC community but each supplier has its own set of rules. For example, data from the French SPOT satellites have always been subject to well-defined copyright rules whereas copyright regulations on the US Landsat satellite series have different terms and various start dates according to the distributor.

7. Public Sector Research Commissioned From NERC

7.1 A number of Government Departments and public sector agencies provide funding for NERC research both through fully funded contracts and through co-funding with NERC for some activities. The following listing indicates broad themes where such funding contributes. Organisations are listed in order of the levels of funding provided, starting with ODA as currently the main customer. The themes listed against each organisation are also in order of relative funding with those receiving the highest level of funding listed first.

Public Sector Organisation	*Themes*
ODA	Mineral Resources, Climatology, Water Resources, Ecology, Pollution
DOE	Pollution and Waste, Oceans and Coastal Zone, UK Environmental Resources, Carbon Cycle, Climate Change, Biodiversity, Genetics, Geophysical Monitoring, Ecology
MAFF	Ecology, Coastal Processes, Risks and Hazards (Floods), Pollution, Water Resources, Biodiversity, Ocean Processes
MOD	Ocean Processes, Navigation/Safety, Technology, Carbon Cycle
DTI	Hydrocarbons, Mineral Resources, Pollution and Waste Management, Water Resources
Northern Ireland Departments	Mineral Resources, Water Resources, Risks and Hazards (Floods), Ecology
Environment Agency (ex-NRA)	Water Resources
Scottish Office Departments	Water Resources, Ecology, Risks and Hazards (Floods), Oceans, Pollution
Welsh Office	Pollution, Risks and Hazards (Seismics), Water Resources, Ecology
HSE	Safety (Offshore Engineering)
DOT	Waste Management

Co-ordination between public sector customers

7.2 The various public sector organisations have their own policy reasons for commissioning research. There are a number of co-ordination mechanisms within the public sector but departments would be best placed to advise the Committee on this point. NERC is involved in some of the co-ordination groups, for example the MAFF Funders Group, the Inter-Agency Committee on Marine Science and Technology and the Inter-Agency Committee on Global Environmental Change and we see no reason to question the efficiency of co-ordination in these areas. From the point of view of a contractor it is, of course, no bad thing for a number of customers to independently commission similar work for their own specific requirements.

WEDNESDAY 6 NOVEMBER 1996

Members present:

Sir Giles Shaw, in the Chair

Dr Jeremy Bray	Sir Trevor Skeet
Mrs Anne Campbell	Mr Patrick Thompson
Dr Lynne Jones	Dr Alan W Williams

Letter to the Chairman of the Committee from Sir John Houghton, Chairman of the Royal Commission on Environmental Pollution (16.10.96)

INQUIRY INTO NATURAL ENVIRONMENT RESEARCH COUNCIL

In June, in response to your Committee's press notice of 23 May inviting evidence for an inquiry into the Natural Environment Research Council (NERC), the Secretary to the Royal Commission sent the Clerk a copy of comments which the Royal Commission had submitted in March for the Prior Options Reviews of NERC's Centre for Coastal and Marine Sciences, British Geological Survey and Centre for Ecology and Hydrology, with the request that the Committee should take these into account in its inquiry. The Royal Commission has subsequently given further consideration to the broad issues facing NERC and, as I understand your inquiry is still in progress, this letter conveys some further views we wish to express.

These views relate to the need for dialogue and co-operation between the Research Councils in advancing scientific knowledge and maximising the contribution such knowledge can make to developing public policies. Inevitably many of the areas of science which are most exciting and important from a policy perspective do not fit easily into the fields covered by individual Research Councils. That is particularly true of environmental issues. Moreover the economic and social dimensions of scientific reseach are increasingly important. There are a number of examples of successful co-operation between Research Councils. What has yet to be achieved however are satisfactory fora, and sufficient priority, for identifying and developing new interdisciplinary initiatives, especially where more than two Research Councils would be involved. While the co-location of all but one of the Research Councils in Swindon ought to facilitate co-operation between them, the possibilities this opens up have not been fully exploited in practice.

We recognise that reductions in the headquarters staffs of the Research Councils may have made it more difficult for them to generate and sustain new multilateral initiatives. While recent developments such as devolution of programme management have had many beneficial effects, we hope that future consideration given to the organisation and management of headquarters will take full account of the staff effort required for positive liaison with other Research Councils and the best ways of deploying such effort.

There is one aspect of the work of the Research Councils where we believe closer co-operation would have particular value. All the Research Councils are devoting greater effort to increasing public knowledge of their activities, and in doing so making a crucial contribution to the wider task of improving public understanding of science. At the moment however they operate separate press offices. Whatever the extent of day-to-day co-operation between those offices, this separation is bound to reduce their overall impact on the media and public opinion at a more strategic level. There may also be a danger that joint programmes will receive less attention than they merit on a continuing basis, in that responsibility for publicising them is likely to rotate between different press offices. We believe careful consideration should be given to the case for establishing a joint publicity team serving all the Research Councils, on the model of their successful joint office in Brussels.

These comments are of a more general nature and do not apply solely to NERC. We are aware that your Committee's inquiry into NERC is one of a series of inquiries into the Research Councils, and we hope they will be of interest to you in that context.

Examination of Witness

SIR JOHN HOUGHTON, Chairman of the Royal Commission on Environmental Pollution and Chairman of Working Group I of the International Panel on Climate Change, examined.

Chairman

98. Sir John, good afternoon. Thank you very much for giving your time to come and meet the Committee and to answer some questions we might be wishing to put on our NERC Inquiry, of which you are aware. I know that you are moving on, so you are coming first and we will make sure that you catch your plane later today. Perhaps I could start by basking you a question about the organisation with which you are associated, the Intergovernmental Panel on Climate Change. Could you tell us something which would help us to define the work that it is responsible for and how this relates to either agencies of one kind or another or to voluntary partnerships and those operating in the private sector? Tell us how you see the structure of this and what its real tasks are.

[Chairman *Cont*]

(*Sir John Houghton*) The IPCC is an intergovernmental body which is a body which is set up to carry out assessments of science. So it does not do science, it is not a research agency, it does not do research, it does not look after research. It makes suggestions about research but it does not do it. It is really there to assess the science of climate change. It was set up in 1988 jointly by the World Meteorological Organisation and the United Nations Environment Programme to do this joint assessment work. What we have done is to make use of all the scientists in the world we could find who work on climate change, and we have been pretty successful in that as there are several hundred of them, and we have worked to describe the science behind climate change, to say where we are, to say in particular what we know and what we do not know. It is often said the IPCC comes up with a scientific consensus and how on earth can you have consensus in science because science is not like that, but we have had a consensus. The consensus is not about all the detail, because there is a lot of debate and discussion about a great deal of the detail which goes on within IPCC as well as elsewhere, but what we have done is to try and delineate what we know and what we do not know. That is particularly useful, of course, to the policy makers and politicians and to people like that, and particularly of course we have been addressing the policy makers. The IPCC has two great strengths which have contributed to its success. Firstly, we have involved a very wide range of scientists—over 90 per cent of the scientists who are actively working in the field in the world have been involved—so our reports are owned by the scientific community and that is absolutely essential if we are going to have scientific credibility. Secondly, because we are an intergovernmental body and because the Policy Makers' Summaries, are agreed at intergovernmental meetings, and the presentation of the science is something which governments have participated in, it is owned by governments, and because it is owned by governments, governments take it seriously and say, "This is our report, so we have to work at it."

99. That at least sets on the record how you see the IPCC working and how it is translated. Obviously this is an area where policy makers have to be persuaded to take action, probably before the scientific case has been proven to the kind of level which most governments might wish before they are required to take action. If we delayed until it was absolutely unarguable that human action produced global warming, it would presumably be too late. Is that right?

(*Sir John Houghton*) It would not necessarily be too late, but the cost of action then might be very much greater. If you are a public company and you are trying to look to your future, you take into account all the things which might influence your business. You might try to make an economic forecast (and that is even more difficult than climate change forecasting, very often), you try to look at how things might change, how society might change and how your business might change. If you are weather-sensitive, you might take a weather forecast and look at how weather might change. If your business is going to be climate-sensitive, then you look at the best forecasts of the climate next century. So governments, to use the analogy of a public company, if they are governments doing their business in a sensible, planned fashion, should also plan for the future on the basis of the best information available.

100. How easy has it been to persuade policy makers to take decisions?

(*Sir John Houghton*) We had the Rio Convention in 1992 and the Climate Convention was signed there and that, in a way, was relatively easy because that is at the level of rhetoric and saying good things and so on. When it comes to what really needs to be done, then of course it is much harder and it is bound to be much harder, because you are bound to be making some decisions which might be in some ways unpopular as well as some that could, possibly, be popular.

101. Does the IPCC and science in general have a role in trying to generate the will to take these actions?

(*Sir John Houghton*) The IPCC as such is a scientific body and we make scientific assessments or predictions or forecasts of what might happen in the next century, and we try as a body to keep away from making policy statements. I think that is very important for us. We have been under some pressure in Geneva recently to actually say what is a 'dangerous' level of carbon dioxide concentration, and we say that it is not our job to say what is 'dangerous', that is the job of the politicians and the policy makers. As soon as we scientists do that, we are in trouble.

102. Do you see any threats to this process?

(*Sir John Houghton*) There has been a lot of debate of course about the role of science and some people have tried to rubbish the IPCC for a variety of reasons, but the process itself is actually very robust.

Dr Williams: I am very surprised at your economic parallel in this, in that most countries, Chancellors even, plan on a 12 month or a five year, at the most ten years or if you are in Japan 25 years, timescale, but you are looking at a 100 year timescale. The other thing is that in economic treaties—the Maastricht Treaty, convergence and the single currency—there are tight definitions and punishments, but here we are dealing with something much more intractable, international and long-term. Trying to persuade governments to reduce carbon dioxide emissions, which is what this is all about, to stabilise them and eventually reduce those emissions, is an intractable problem and I think your economic parallel diminishes massively the—

Dr Jones: We would have a much more sensible economy if all businesses behave in the way you suggest!

Dr Williams

103. The question is that the dimensions of the problem are a million times more difficult than tackling economic problems, are they not?

(*Sir John Houghton*) I was talking only yesterday with one of the largest of our industrial companies which is very interested and concerned about climate change, and they want to hear about it and plan on

[**Dr Williams** *Cont*]

the basis of the best information available. It is a 100 year timescale but then it does have implications for the next few decades. If you are building a power station you are building it for 30, 40, sometimes 50 years, and you have therefore to take account of what the situation is likely to be concerning the environment on that timescale. If you are a company you should certainly try and do that; if you are a government, even more so.

104. Do you foresee a time, say in 20 years time or whenever, when it is so widely recognised that we must take decisive action, that there would need to be punitive sanctions for the United States, China and all the other countries to actually live within whatever the level is that is prescribed for CO2, as will be the case with the single currency?

(*Sir John Houghton*) It is hard for me as a scientist to comment on what sort of degree of coercion is going to be required, in the end it is for governments to do it. What I would be very concerned about at the moment, and what the debate is largely about, is what are the actions we can relatively easily take now, either in real terms like becoming much more efficient in our energy use—which we can do, people just need incentives to do it—or secondly what action do we need to take now to plan on the basis of the best forecasts we can give. Because to assume that nothing is going to happen, that climate will not change, is actually a very poor forecast. Our best forecast is that climate is bound to change.

Mr Thompson

105. I want to pick up on the back of something said a few moments ago and that is the question of the relationship between the responsibility of scientists and the responsibility of politicians, and you made specific reference to it a moment ago. When I first learned biology when I was about 8 or 9 years old, one of the very first things I remember being taught was that carbon monoxide is poisonous, and I was told by a scientist why it was dangerous. I hope you can rephrase the answer you gave a moment ago when you said that it is not the scientist's job to say what is dangerous. I realise what we are talking about now is far more complex than that example, but as someone who was originally trained as a scientist I am not prepared to accept what you just said, that it is not the scientists' job to say what is dangerous. I think I know what you are driving at but could you rephrase that in a way which certainly I can accept?

(*Sir John Houghton*) Let me put a gloss on it, because perhaps it is misleading to say it as I have said it. The word "dangerous" has a particular connotation in the Climate Convention, because the objective of the Climate Convention is said to be to stabilise carbon dioxide concentrations at a level and on a timescale which prevents dangerous anthropogenic interference with the climate system. So the word "dangerous" has that particular connotation in the IPCC context. What the IPCC is trying to do is to say that if we have certain levels of carbon dioxide, which therefore implies certain amounts of climate change, the impacts of that on things like sea level rise, floods, droughts, disasters of various kinds, food supply, water supply, will be the following, insofar as we are able to spell it out. But it is not for us to say which level is really dangerous. There are deleterious effects all down the line but choosing a level is not our job. It is politicians and policy makers who have to balance out—

106. So you can describe the effects but not choose the level?

(*Sir John Houghton*) We have to balance that against the impact and the cost of doing something about it. That is not unusual in an environmental field. We spell out that this substance is potentially dangerous, certain levels have certain impacts, the cost of doing something about it is the following, but politicians have to balance those out.

Dr Bray

107. Sir John, you have been Chairman of Working Group I of the Panel on Climate Change since the inception of the IPCC and you were so at the time of Rio?

(*Sir John Houghton*) Yes.

108. But you were not invited to attend Rio?

(*Sir John Houghton*) I was, but I did not actually go there.

109. Do you think you did have a role there or should have had a role there?

(*Sir John Houghton*) Science was well represented there and that part of the process had gone by. I had just taken over the Royal Commission and I was keen not to miss my second meeting, so I thought that was more important than going to Rio where I would have been one amongst hundreds of people.

110. In your opening evidence you spelt out very clearly that it was not the job of the IPCC to do the research, nor presumably to manage it, but to review it.

(*Sir John Houghton*) Yes. We have certainly done some of that and you will find in a volume in front of you a chapter devoted to research.

111. It is a huge task to review. That task is carried out by a very small staff but an efficient one, evidently. The staff is based in the Met. Office?

(*Sir John Houghton*) Yes.

112. So they are not a million miles away from where the research is done?

(*Sir John Houghton*) Yes, that is right.

113. On the way the research actually is done and the research is actually managed, you have seen the Climate Agenda document which is under discussion by WMO and other agencies?

(*Sir John Houghton*) In fact I chaired the first meeting of the Climate Agenda, which was the first intergovernmental meeting I think which set that whole thing off.

114. Presumably you agree with the broad line it has taken?

(*Sir John Houghton*) Yes.

115. Can I ask in particular whether you are happy about the summary of the way it works expressed in the Climate Agenda, as: "The fundamental tenet of the World Climate Programme is that the climate problem is best addressed through the voluntary

[**Dr Bray** *Cont*]

contributions of nations to international programmes which they have had the opportunity to design." That is a different way of organising research from that of having an intergovernmental agency actually to do the research. Do you feel one might describe the voluntary group of nations doing pure modelled research as likely to be more efficient?

(*Sir John Houghton*) I think if you try to set up some great international monolith doing research into climate over the wide range of disciplines which are involved, that would not be a success and it would not be cost effective compared with the procedure of having an international body which is small in its secretariat but which brings together scientists from different countries, different disciplines, comes up with proposals as to how the science should move forward, proposals which can be in considerable detail and should be in considerable detail regarding what is required, and then for those proposals to go out to governments, to agencies within countries and appropriate bodies for support. That has actually worked quite well in both the World Climate Research Programme which I know well because I chaired its main committee for some years, and the IGBP, which is the International Geosphere Biosphere Programme run by ICSU, and that also has been very successful working along those lines. I would run very fast away from a big, international, monolithic body.

116. Do see any obstacles to the adoption of the Climate Agenda, which I understand still is not formally adopted?

(*Sir John Houghton*) The difficulty with organising research and science in that way, particularly in an area like climate, is that climate covers a very wide range of scientific disciplines. Many government departments in all countries are interested or potentially interested in climate science and in what climate science can deliver, and in most countries there is not one particular department which is the department dealing with climate, there are many of them. There is therefore a difficulty when it comes to international bodies which are attempting to put together an international programme—you can get your scientists together, that is fine, but you also need to involve the funding agencies and the government interests if you are going to get resources and if you are going to get an operational programme or quasi-operational programme which is going to meet the needs of those who want answers.

117. From the UK point of view there is, firstly, the contribution the UK Government makes to the research, to funding the research, and secondly, there is the influence which the UK Government may be able to bring to bear on other governments to fund their research. Are you satisfied those two interests are being properly managed in the UK?

(*Sir John Houghton*) I think the UK has great potential and a lot of experience in the international sphere and does it actually very well. But I do see this difficulty, not just in the UK (although in some ways particularly in the UK) but also with other governments, in that there is a weakness in the process of looking at the total international programme and assessing it in the round just because there is no UK body which sits over the climate agenda as the body responsible for making sure the UK contributes to it in a sensible way, and also making sure the whole programme is as sensible as possible. When it comes to the UK's contribution to the Climate Agenda and the whole of international climate science, there is this difficulty of just who takes the lead in that in the UK, and that is not clear.

118. There is the august body chaired by the Government Chief Scientific Advisor on which the chairmen of the Research Councils sit, which is not an expert body in any way presumably although it has overall responsibility for research into climate change. Does it not actually perform this executive job?

(*Sir John Houghton*) That is not the only body, of course. It is not just the Research Councils which are involved or the Met. Office, which is part of the Ministry of Defence, you have the Department of the Environment who have a clear interest in it, you have the Department of Trade & Industry, you have the British National Space Centre, there are lots of people who have a potential interest in this whole area. Although there is a lot of co-ordination of activity, it is not just co-ordination we want, we need somebody to take the lead in the whole activity so there is a coherence in the programme which satisfies UK needs and is the most cost effective programme you can come up with, and that is still a problem.

Dr Jones

119. How do we feed into the International Panel then, because surely the feed through from Britain into the International Panel requires that function?

(*Sir John Houghton*) There are people from various departments who go when there has been a meeting of the Climate Agenda.

120. So it is just *ad hoc* different representatives from Britain?

(*Sir John Houghton*) There are *ad hoc* different representatives, yes.

Sir Trevor Skeet

121. Sir John, if I understand the position, you make rather useful assessments from time to time but there remains a great deal of uncertainty in this particular field? How can you make your correct assessments if all the data is not in, such as the World Ocean Circulation experiments which will not report until later? These must be pretty uncertain assumptions, must they not?

(*Sir John Houghton*) The degree of uncertainty of course is dependent on the amount of research and the amount of data we have. That will improve as the years go by and indeed has improved over the last five years since we made our first assessment. The World Ocean Circulation experiment, for instance, has produced a lot of data already and our knowledge of the oceans is a lot greater than it used to be because of that. It will be much greater in the future also.

122. Therefore the quality of your assessments will be improved as more information flows in?

(*Sir John Houghton*) Yes, our projections are being refined and the science is being improved and we are uncovering other unknown factors, in some cases, as well. It is interesting in this assessment process that

[Sir Trevor Skeet *Cont*]
what we are saying in 1995 does not differ fundamentally from what we said in 1990, so during that five year period there has been a tremendous amount of scientific activity and experiments and we are saying very much the same message and giving very much the same forecast.

123. Yes, but the debate has been over the prediction of global change itself, and not on the implications to the biosphere?
(*Sir John Houghton*) Yes.

124. What are these implications like to be? How are they likely to come out?
(*Sir John Houghton*) The very simple answer as far as climate change in the next century is concerned is that if we carry on burning fossil fuels at the current accelerated rate, which is business as usual, so we more than double the carbon dioxide content of the atmosphere from its pre-industrial level by the middle of the next century, then the average temperature of the globe will go up by 2 or 3 degrees next century. That does not sound too much perhaps except when you realise that the difference between the middle of an Ice Age and the warm periods in between Ice Ages is only 5 or 6 degrees, so 2 or 3 degrees is about half an Ice Age in terms of the amount of change. And to do that in 100 years represents a very rapid change indeed, and that is our median estimate. It may be faster than that, it may be a little slower, but that is the best estimate we can make in terms of global average temperature. In terms of impact on parts of the climate system, that implies some sea level rise, perhaps half a metre by the end of the next century, which is not too bad for us although it will make for some difficulties but if you live in Bangladesh or the Nile Delta or parts of China it will be a disaster. The hydrological cycle which produces the precipitation and the water resources will change, and the likelihood is that we will have more floods and more droughts worldwide because it will be more intense; a warmer world has more intense circulation. That is a fairly robust result from the science and from the models and that is quite important too.

125. Can I put this point to you: the ozone layer which has been penetrated—there is a very substantial hole in it at the moment—has happened before but it rectified itself when you had not got these noxious gases interfering with it. Would not time by itself rectify this hole?
(*Sir John Houghton*) The ozone hole is of course a different piece of science. The ozone hole results from chemical reactions in the stratosphere where the ozone has been destroyed, and if you stop producing the chemicals which destroy it in due course the ozone hole will recover. It will take about 100 years because these chemicals last for rather a long time in the atmosphere and do not decay very quickly. In the case of climate change or global warming, what we are doing to the atmosphere is burning fossil fuels, increasing the amount of carbon dioxide, and if we stop burning fossil fuels eventually the carbon dioxide concentration will go down although nobody is suggesting we can actually stop burning fossil fuels completely because our energy of course depends on it.

Mr Thompson

126. But it is not just the burning of fossil fuels which produces carbon dioxide, you have other activities as well.
(*Sir John Houghton*) Burning fossil fuels is the largest source by far. There is also, of course, the burning of tropical forests which adds about 15 or 20 per cent to the total carbon dioxide.

Dr Williams

127. The problem you are looking at is interdisciplinary with biology, physics, socio-economic, geographic elements as well, and the structure of the programme involves so many multi-national agencies and research done in 16 different countries. Is it possible to co-ordinate that effectively?
(*Sir John Houghton*) Yes, I think it is. It is very important to co-ordinate it effectively because otherwise you get a lot of duplication and science of this kind is very international indeed. Any group of any competence, any real skill, is not only working on their own but working with people all over the world, and they are connected of course by electronic and other means, because we also require observations from right round the world. The monitoring of climate is something which is basically an international task. Because of that, there are these very strong links in the scientific field, so co-ordinating it is not too difficult. You did mention socio-economics and the social sciences and that is an area where they do not have quite the same tradition of international links, and getting physical scientists and natural scientists to work alongside social scientists in the way that is necessary if you are going to answer the questions which are being asked—like not only how will climate change but what we can do about it—and pulling projects together on an interdisciplinary basis is actually quite difficult. Some of us have been trying recently in this country to bring the scientific interests from natural scientists and social scientists together, trying to get joint projects between these separate sciences, and it is actually quite hard to do but we should try very hard to do it.

128. But the size of the problem compared, say, to the ozone hole, which was limited to chemical pollutants, or the acid rain problem which is much more localised and has an easier solution with possible chemical fixes, is the largest environmental problem we have ever had to grapple with.
(*Sir John Houghton*) Sure.

129. The solutions are much more difficult in that with the ozone hole there are alternatives to CFCs and we are solving the problem on acid rain, and that is why I attacked you a little earlier in saying you were in a sense diminishing the enormous magnitude of the problem you have to crack.
(*Sir John Houghton*) I was not trying to do that, I was trying to illustrate to you perhaps that we can tackle it as a human race. I have been most encouraged by the way in which the scientific community, which when we first began in the IPCC was very suspicious of trying to make assessments in such an area of great uncertainty, has tried to pull

[Dr Williams *Cont*]
scientists together worldwide from very different backgrounds and cultures, saying, "Please can we come up with a consensus report", nevertheless has done it, and they have done it not only willingly but gladly and they have enjoyed doing it. I think that it is most encouraging that scientists have got a grip of the whole thing in that way.

130. What about that step from the scientists in research into that social economic, political area? Will you ever be able to take that step?

(*Sir John Houghton*) The IPCC has tried to do that in its last report. We now have a volume which is very similar to the size of the one Dr Bray has over there, which is devoted to the economics of the problem. It would be unfair of me to say it is not of the same quality because I have been involved with one and not the other, but it is starting from further back and economics is a much more difficult discipline in many ways and they have to build on the natural sciences in what they are trying to do. But I think it is a very major step forward, getting economists around the world actually working together on how to find ways of tackling the problem; what are the economic pros and cons of doing it this way rather than that way or not doing it at all.

Mrs Campbell

131. Focusing on the national research which is going on at the moment, do you feel the research council structure makes it rather difficult to develop these interdisciplinary initiatives which you have highlighted as being important? Is it the research councils structure in this country which makes that difficult? If so, do you have any submissions to propose to them?

(*Sir John Houghton*) Very recently I was involved in a meeting on transport which picked up on the Royal Commission report on that theme, in which all the research councils were involved in trying to get together scientific workers across the disciplines to look for projects covered with transport which had a joint content between the natural and social sciences. The meeting took a lot of organising and it was hard to get people doing this because it is difficult. I think the research councils, as far as I can judge, are trying to work together closely in these areas and they should be encouraged to do so. I will just make the further point that of course all research is not done by research councils, there is a lot of research outside in other government departments and elsewhere which needs to be brought into the whole scheme of things in not just a co-ordinated way but a clearly defined way.

132. There has been recently a very accelerated slimming-down of headquarters of the research councils, and I wonder if you feel that has had any deleterious effect in helping them to work together more effectively?

(*Sir John Houghton*) I have not been very close to it, so I cannot really comment on whether it has been a problem or not.

Dr Williams

133. When you compare the UK with the United States, are we pulling our weight internationally in our contribution to global environmental research? If we are, how much of that contribution is due to NERC, the environmental research council?

(*Sir John Houghton*) I cannot be quantitative about it but we are playing a very good role internationally in this whole area of research. We are about second to the US, and the US of course does have a very big budget and a large number of people working on it and they have a great deal of interest in it. We are very clearly second to the US in the quantity of research, and we are equal to the US in the quality of the research. We have some of the leading centres in the world in this area of things, and NERC scientists are at the front working in the various areas in which NERC is responsible. So NERC is, on the quality of its science, doing a very good job indeed.

Mr Thompson

134. Following up on that point, are there any countries, particularly European countries, when talking about research councils, who organise these things better from whom we can learn lessons? Or are we really second to the US and that is something to be very pleased about?

(*Sir John Houghton*) If I could come back to this organisational problem, which I think most countries have and which we have possibly worse than others in some way, it is the problem of the demarcation between different government departments and agencies concerned with climate.

135. Are there any countries, perhaps not too far away, who manage to do it a little better?

(*Sir John Houghton*) The US is now pulling it together much better than they did.

136. But other than the US?

(*Sir John Houghton*) The Australians are pulling it together rather well, for instance, and they have a very great interest in climate and they do this rather well, but it is a severe problem in a lot of places.

Chairman

137. I think you may have answered this question previously. NERC obviously has areas of research which deal with climate change, which deal with the work of the Royal Commission on environmental pollution, and of course there are other bodies like the Met. Office, the DOE, the NRA and the new Environment Agency, and all these are doing research of one kind or another which relate in some way to the issues you have been discussing. Are you satisfied these responsibilities (which I appreciate are not your own) are being properly co-ordinated?

(*Sir John Houghton*) There is a great deal of co-ordination which is going on and people of all departments are aware of what other people are doing. I think that co-ordination works very well. What is not being done, I think, is the real leadership role which looks at the problem as a whole from the point of view of the UK as concerned, for instance, with the Climate Agenda which is the attempt of the

[Chairman *Cont*]

international bodies to put the whole story together. The UK does not have a lead department which has taken the responsibility for the whole of this science and which tries therefore to make sure it is all done in the most cost effective and sensible way. Lots of people have different interests and that co-ordination is done very well but the overall leadership, which is also needed is not actually being tackled.

Mr Thompson

138. If we did have a lead department like that, where would it be and what would it be? That is a very important point.

(*Sir John Houghton*) The obvious contenders for that would be NERC and the Met. Office, and maybe they could do it together. There would be a lot to be said for giving responsibility very clearly to a research agency like NERC jointly with an operational agency like the Met. Office, because those two tasks are very complementary, and for them to be told to come up with an agenda for climate research, including monitoring, because monitoring is very important.

Dr Bray

139. In fact the departmental responsibility clearly lies with the Department of the Environment, which you did not mention. In personal terms, are not the actual people who play the biggest role in the management of climate research in the UK on the one hand David Fisk, the Chief Scientific Advisor and Julian Hunt, the Director-General of the Met. Office?

(*Sir John Houghton*) I did not want to in any way decry the role the Department of the Environment has played because it has a very important role and they have been supporting the Hadley Centre at the Met. Office and a lot of the Met. Office work in this area, so by saying the Met. Office I was including within that the role they have in working under contract with the Department of the Environment. So that part of the programme I was including as part of the Met. Office programme. The Department of the Environment has a responsibility for human-induced climate change yet they do not have any responsibility for natural climate change. So basic research which is required to study climate change is not a Department of the Environment responsibility, as I understand it, but the pollution component or the human-induced component is their responsibility.

140. You have underlined a strength in the UK and that is that the weather forecasting apparatus is the same as the climate change apparatus.

(*Sir John Houghton*) Yes.

141. They are in the same institution, they use the same computers, they are working alongside each other. That is not the position in the United States nor in many other countries.

(*Sir John Houghton*) No, and that is a great strength of the climate change work which is done by the Met. Office.

142. But a weakness, surely, is that in the UK the Met. Office is unique in being under the Ministry of Defence?

(*Sir John Houghton*) That is not necessarily a weakness.

143. Not necessarily a weakness, but it is a difference.

(*Sir John Houghton*) It is a difference.

144. It therefore clearly introduces management questions when it comes to finding the budget for research programmes and so on?

(*Sir John Houghton*) I know that very well because I was at the Met. Office, as you know, for sometime, and the way in which the Met. Office is set up is just one of the possible ways you can set it up, but I was content with the Met. Office being in the MOD because the MOD is one of the biggest customers for weather forecasts.

Chairman

145. Do you get the impression that climate research is better organised than pollution research? If so, why?

(*Sir John Houghton*) Climate research does have its pollution aspects, of course, and some people would consider the carbon dioxide problem as a pollution problem. The pollution research is carried out in very many places and it is not dissimilar in many ways from the climate change area. The Environment Agency has a big responsibility also for pollution control and therefore for making sure that research is done well, and I think it is very important the new Environment Agency, which does have very good connections with NERC and the Met. Office and other bodies, can help them in the research and monitoring which is required in order to carry out their duties. I would not say it was worse organised. I think the co-ordination there is actually quite good as far as I have seen it from the Royal Commission work we have done.

Dr Jones

146. I am very confused about all these agencies. We have the Intergovernmental Panel on Climate Change, which we discussed earlier, the Interagency Committee on the Climate Agenda, and the Interagency Committee on Global Environmental Change. Those are all international bodies, is that right?

(*Sir John Houghton*) No, the last of those is not.

147. The last is a UK body which is involved with the UK Global Environmental Research Office?

(*Sir John Houghton*) Sure.

148. In terms of the international level, what is the relationship between the Interagency Committee and the Intergovernmental Panel?

(*Sir John Houghton*) The Intergovernmental Panel is the assessment body which I have been very involved with and have chaired for some years. We are just assessing the science on climate change.

149. Yes, so what does the Interagency Committee do then?

[Dr Jones *Cont*]

(*Sir John Houghton*) The Interagency Committee is the body which is overseeing the international research programmes concerned with climate change.

150. Are they commissioning any research?

(*Sir John Houghton*) They do not have any money, they are not commissioning anything. They are trying to make sure the programmes are well co-ordinated, that duplication is avoided, that programmes have proper thrusts and are cost effective in the way they are set up and the way they are trying to do things.

151. Is there not some duplication in these two bodies though? I know one is just assessing, but surely in order to do the role you have just described on the Committee they have to assess what is going on as well?

(*Sir John Houghton*) They assess what research needs to be done.

152. But to assess what needs to be done, you have to assess what has been done.

(*Sir John Houghton*) The Intergovernmental Panel is assessing from the point of view of saying what has to be done internationally to cope with climate change, it is not a scientific question so much as a political one. We are assessing for policy makers the science of climate change.

153. You are satisfied that this is an appropriate set-up?

(*Sir John Houghton*) Yes, they are separate functions. Although they are connected, they are quite separate functions.

154. Can I then ask the question I was supposed to ask, which is about the maintenance of long-term data sets? Are you satisfied that the responsibility for the maintenance of this information is recognised and that the responsibility is appropriately divided between departments and NERC?

(*Sir John Houghton*) The need for long-term monitoring, long-term measurements, is recognised, and the whole of our understanding of climate, of ozone and any other pollution areas, depends on continuing measurements of high quality which are consistently calibrated and which can be used to show things are changing. That is very important. It is not, of course, front line scientific research in the sense that is attractive to a man or a woman in a university doing research and trying to make a name for himself or herself; they would be doing more frontier research, but it is terribly important to have bodies doing this monitoring and measuring. Sometimes it is quite hard to get funds for it. Now I am not satisfied this is being properly addressed in the long-term from the UK climate point of view. The Met. Office has responsibility for weather observations, it does not have any formal responsibility for monitoring climate observations which are not connected to its main weather business. The Department of the Environment has taken on some role in monitoring from space; there is the British National Space Centre which should be looking after some of this from space but again it has the problem that it does not have the leadership role within it because of the way it is set up which will enable that to be done.

155. So what would your solution be to this problem?

(*Sir John Houghton*) I think the lead department solution is a very important concept; to find a department, or joint departments possibly would be appropriate, to take the lead.

156. So we are back to your NERC and Met. Office solution?

(*Sir John Houghton*) Yes, to be given resources to take on that leadership role, and for it to be accepted government-wide that they have the leading role. I think that would begin to solve the problem.

Mr Thompson

157. I am not clear whether you are talking about an agency or a government department or some other body. This question of lead body keeps coming up and it is obviously very important, could you describe what you mean? Do you mean a government department or do you mean an agency or some other body?

(*Sir John Houghton*) It could be a government department or an agency.

158. What would you prefer it to be, in an ideal world? What would you like it to be?

(*Sir John Houghton*) It has to be a body which has the competence to be recognised as a competent body to do that work.

159. So does it have to be a government department?

(*Sir John Houghton*) So I think it has to be a government department or a government agency.

Dr Jones

160. What about the Global Environment Research Council?

(*Sir John Houghton*) Well, that is a co-ordinator. You have perhaps ten parts of government who are interested in climate, who say, "Yes, this is very important to us, we think it is important and we have an interest in it." They sit around a table, they co-ordinate what they do, and that is a very important thing to do, and the ISEG (?) has a very important function in that regard. But unless somebody around that table has the lead responsibility—

161. Does that mean a budget and money?

(*Sir John Houghton*) It means budget and money; it means resources.

162. If it was allocated a budget, that body could do it?

(*Sir John Houghton*) If you pass a hat round among 10 people and say, "Here is something we want to do, we all think it is a good idea, will you please put something in", they will all say, "Sorry, my budget does not allow me to do that" because it is somebody else's responsibility. You have to actually identify one or maybe jointly departments or bodies which will actually take the lead and in some sense pick up the bill. How that is arranged financially is a

[Dr Jones *Cont*]
matter for the departments to which they belong, but somebody has to be recognised as that lead person. If that happens, the potential that the UK has in its scientific competence and its international skill in defining programmes internationally, in taking the lead, would really be realised.

Chairman

163. I think that is a very appropriate point on which to end, if I may say so. We have concluded our session with you, Sir John, and we are very grateful to you. I think we are also grateful to you because it takes a big man to run a big organisation and, my goodness, you are doing that. We wish you well in whatever you are doing. Thank you for your time.

(*Sir John Houghton*) I am just off to an IPCC meeting now!

Chairman: Very good!

Examination of Witness

DR PETER COOK, Director of the British Geological Survey, examined.[1]

Chairman

164. Dr Cook, you have the advantage of at least seeing the Committee in action with your predecessor in the seat. I am most grateful that you have agreed to come and give us some advice on the issues we are trying to research into. As Director of BGS you have a very important role to play in these issues. Could you answer an easy question first: BGS has been praised as at the cutting edge of geological science. How does it compare with other similar institutions in other countries?

(*Dr Cook*) You are quite right, every country to my knowledge has a national geological survey and they vary in quality. The World Bank did a recent review of the quality of national geological surveys, not because it is concerned with geological surveys *per se* but it is concerned with the sort of information which was becoming available and the resources. It indicated four grades of geological surveys, and the BGS was in Grade A and we were specifically mentioned, along with the US Geological Survey, as being examples of the top geological surveys in the world. So that is the word of an international body; you do not have to take my word for it. If you would like to take my word for it, I believe the British Geological Survey is absolutely outstanding, but I would, wouldn't I!

165. What are the reasons for its relative strength, because it is way up, punching higher than its weight?

(*Dr Cook*) Certainly the fact it has been around for a long time is a help. The British Geological Survey has been around for 161 years and we have had the opportunity to grow and we have built upon that strength. We are not pre-occupied with the past but we are very proud of that past; we are actually more concerned with the future but, nonetheless, that provides us with a very good jumping-off ground. We believe the way we do things, this mix of public sector and private sector, is also helpful in the current climate; we think it works. Also we do work internationally—we work in 40 or 50 countries at the present time and that is also a very important thing. It gives us a breadth of experience which is unique, I believe; I do not think any other geological survey in the world has the international programme we have.

166. Is that something you have, as it were, initiated the BGS doing? Or do those other countries have a need which they do not meet themselves and they have asked you to look at it?

(*Dr Cook*) We have a variety of roles overseas. Essentially we are responsive to the customer, and the customer may be the ODA, it could be a foreign government, it could be a foreign bank. In recent years we have seen less funding coming from the ODA to support our work and more of our funding has been coming from the World Bank, the Asian Development Bank, organisations such as that. So it is primarily customer-responsive.

Sir Trevor Skeet

167. Dr Cook, are you not hiding your light under a bushel? I can recollect from experience that you produce annually a very good manual[2] on the world coverage of metals, which is not only admired in the United States but admired here and right throughout Europe and elsewhere, and there is no similar document to yours.

(*Dr Cook*) I am delighted to hear that I am hiding my light under a bushel, I am seldom criticised on that score. Thank you for bringing that to my attention. You are absolutely correct, it is an outstanding publication, it is a very important publication, which industry worldwide regards very highly. It is a very important one, for the minerals industry.

168. Can I ask you about your data base as well, because I think this is important and it will come up later on. Just one point I wanted to put to you: if you ceased to exist, the data base would not be continued by anybody else either here or abroad and we would be in some considerable difficulty, would we not?

(*Dr Cook*) That is correct. Within a relatively short time the data would become obsolete, a number of commercial organisations would have nothing to

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[1] *See* Volume II (HC71-II), p 48, for Dr Cook's memorandum.

[2] *Footnote by witness:* The manual is "World Mineral Statistics", published annually by the BGS.

[Sir Trevor Skeet *Cont*]
base their future plans on, it would be a very serious issue within a few years. It varies depending on the data base, of course, but you are absolutely right.

169. When it comes to world mining, of course, you are an authority not merely for what is mined in the United Kingdom but for what is mined in China and all countries of the globe?

(*Dr Cook*) Yes, we try and keep track of what is happening throughout the world on behalf of the Department of Trade & Industry; the minerals division of the DTI.

Mrs Campbell

170. I think your organisation has perhaps a rather different management structure from some of the organisations under NERC, and I wonder if you could explain to us how you have taken advantage of the management delegations from NERC and how independent you are of NERC?

(*Dr Cook*) I am glad to say both the present chief executive of NERC and also his predecessor, John Knill, were in favour of devolution of responsibility. That is very much my style, I really do not feel the need to refer things back, by and large I am able to tell them what I have done and they are happy with that and that I should be judged on my deliverables. That is the basis on which I operate. So I use devolution of responsibilities to the maximum.

171. That is in operational terms, what about the scientific programmes?

(*Dr Cook*) One of the very important features of the management of the BGS is that we have a board and that board is made up primarily, not exclusively, of people from industry. This is very valuable, it provides us with insights into industry, insights into opportunities, it strengthens our links with industry. For example, Richard Hardman, the exploration manager of Amerada Hess is in this room now, and he was a member of the board for several years. They play a very important role indeed and they help to define what we call the Core Programme. The Core Programme is the public good programme we undertake, in other words it is a programme that is done for the UK public, for UK industry, for UK Government; there is no one customer, it is a national good programme. That was defined a number of years ago and what the board does is ensure we maintain the quality of that programme, the deliverables of that programme, and it also refines that programme.

172. So what you are saying is that your programming is determined more by the board than it is by NERC?

(*Dr Cook*) Yes, that is fair comment.

Sir Trevor Skeet

173. While you are a part of NERC, and of course they supply most of your funds, would you like to be independent?

(*Dr Cook*) It would depend upon the terms of the independence, Sir Trevor. There are a number of issues, for example we would need a guarantee of long-term funding for our long-term programmes. We would need to ensure that we maintain quality in the independence. All of these sort of things are very important. If you are saying, "What is our relationship like with NERC", the relationship with NERC is good, I have a good working relationship with the present and the past chief executive. I do have some concerns about the complexity of the NERC arrangements and the cost of those complexities and some of the levels. All of these things do cause me concern and on occasion you think, "Yes, it would be nice to be independent", but I think it would be very important to look at the fine print of that independence. Certainly the number of levels, which are in some ways endemic to the British system I suppose you could say, do cause me concern.

174. Have I got it correct, that, yes, you would like to be separately funded but with guarantees?

(*Dr Cook*) We would like to have guaranteed funding to undertake our Core Programme. That is a concern to us. If staying in NERC could not provide that guarantee, we would like to be in a system which would guarantee that funding. That is our biggest single concern.

175. What was the recommendation therefore of the Butler Report?

(*Dr Cook*) The recommendation of the Butler Report was that we be an independent, free-standing organisation, yes. We have no problems with that recommendation provided we have the funding.

Dr Jones

176. Could I ask you what your view is of government departments' ability to act as informed customers when they are commissioning work with you? Or perhaps other bodies you are aware of, and their recognition of the need for underpinning of contract work by basic research?

(*Dr Cook*) It varies from department to department and within departments. I do have a number of concerns on that score and I suppose in some ways we have more difficulties with departments which maintain cells of scientists than we do with those who do not have cells of scientists, which sounds rather strange but nonetheless that has been the situation. I think it is rather difficult for that competence to be maintained. If we could just touch on the broader issue of customer-contractor relationships, what we have found as a result of moving into that sort of relationship with government departments is that we have more and smaller contracts and the overall spend is significantly less. This has a number of consequences. One of the hidden costs of this approach is the cost of marketing and winning contracts. Each time you go out to contract it is a fact of life that it probably costs us, to prepare a contract, about £10,000 as a general figure. If a government department calls upon five organisations to tender, each of those organisations is spending about that sort of money, so £50,000 is going into that.

177. For what size of contract?

(*Dr Cook*) It varies. The larger the contract, the greater the cost of course, but it is not actually a linear relationship. The size of the contracts that we do: typically with the UK our spend in a year with the ODA is about £2 million, for example.

[Dr Jones *Cont*]

178. I think we have 3½ million here.

(*Dr Cook*) You could be right, 3½ million. That is our largest contract, after that they get significantly smaller. Our contract with the hydrocarbons area of the DTI would be about a quarter of a million a year, something like that. We can give you the precise figures on that if necessary. Our overall contracts with government departments are probably in the order of 5 or 6 million in total.[3]

179. But the individual contracts that you are spending £10,000 on is what I was getting at.

(*Dr Cook*) I see. That is extremely variable. Typically £50,000 or £100,000 these days. They are quite small.

180. So almost 10 per cent is actually tendering?

(*Dr Cook*) It can actually be very costly, yes, and that is a concern to us because that has to come out of the science really.

181. Why has this trend developed for smaller and smaller contracts? What is the advantage to the commissioning department? Why are they doing it?

(*Dr Cook*) You would have to ask the departments, but I think it is a view that this is the way you achieve the most cost effective science. I am not convinced that it is and I have one or two reasons for saying this. One is that we work a lot with industry, much of our funding comes from industry and we find industry are not that interested in going out to tender on these things. What they do is develop a long-term relationship, they understand the science, they talk to us about our cost, then they acknowledge we need 10 per cent or 20 per cent on top of that, and then they will agree we are the best people to do that. In other words, a single tender situation. In the case of government departments, for the most part the view is that you cannot get a commercial price on that basis and it would seem there is a view in Whitehall that you have to go out to tender. We believe there are considerable costs in this. For example, the work we used to do for the hydrocarbons area of the DTI was done by a single contract, and when that went out to tender that single contract was split into five contracts and five tenderers received those five contracts. In other words, what was done by one group was done by five different organisations. We have found a number of difficulties arising as a result of that. We won one of those five contracts and we find it difficult to work in that situation because of the fact we are now dealing with five groups rather than one group. There are hidden costs in this sort of thing. Nobody will acknowledge them, nobody will cost them, but they exist.

Chairman

182. Who else, other than you, tenders for government contracts?

(*Dr Cook*) A large number of organisations would tender for a government contract. There is a range of contracts for small parts of our programme. Nobody can match us in terms of the breadth we bring to the programmes, but in terms of small parts you can break down our programme and a hundred different groups would do our programme but nobody can do the whole thing.

183. If it was not for the financial arrangements, would your relationship with NERC actually disappear? What else, if anything, do they subscribe to?

(*Dr Cook*) The funding we get from NERC was essentially given to us as a consequence of the Butler Report in the 1980s, and they identified the need for a national geological survey and the deliverables that need to be provided through that national geological survey. Essentially it was decided £12, £13 million, whatever it was, would go to the BGS to undertake that programme. That money came through the research councils. Certainly it could come through some other route. For the most part, we pursue our Core Programme, we deal with multi-disciplinary science on the margins of BGS and that is where NERC comes into it. That is not to minimise the importance of that, multi-disciplinary science can be important and you actually can define an organisation on the basis of its margins, if you get my meaning. So I am not in any way minimising that. Yes, we could exist without NERC; demonstrably we have done that for 130 of our 161 years.

Chairman: Yes, you were there long before NERC was founded.

Dr Jones

184. Going back to the departmental commissions, you were suggesting there were some departments which were better or worse than others and you suggested those that were worse were those which had more scientific involvement. Would you like to give an example of a good department and a poor department and what factors have led to those differing cultures and competencies?

(*Dr Cook*) I would use the same department and say that in the DTI we have overall quite a good relationship with the minerals part of the DTI. They do not actually have any technical competence in there in terms of the other sciences, we are their arm, if I can put it that way, and we have developed a good relationship there. Our relationship in the hydrocarbons area has been a more uneasy relationship and there they probably have a dozen or so scientists, in other words they have a small technical group.

185. Who can evaluate tenders perhaps?

(*Dr Cook*) Who can perhaps evaluate tenders, yes. But in fact it is very difficult of course for a small group of a dozen or so scientists to equal the competence of an organisation with 500 scientists. There is a tendency to try.

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[3] *Footnote by witness:* The projected total BGS receipts from ODA in 1996/97 are £3.6M. There are 54 separate contracts, ranging in size from £63k over one year to £2.5M spread over 5 years. The value of the BGS Geological Advice Contract with DTI in 1996–97 is estimated at £252,000.

Mr Thompson

186. We have been talking mainly about finances and structures and the relationship between the BGS and Prior Options, but you have been talking about scientists, and presumably the British Geological Survey and/or NERC must be concerned about the quality of people qualified in geology and associated sciences who are joining your staff and your research teams. I wondered whether (and this is something perhaps we do not talk about enough) you can say a little about whether you are able to get all the quality staff you need, in other words whether there are sufficient of them, whether they are suitably qualified, whether the universities are supplying the right kind of people and so on? I know this is a slightly different subject from the one we have been discussing this afternoon but it is important because this is about people and without them none of this work is done.

(*Dr Cook*) Yes. Numerically we are certainly able to get the people in. If I can use an example, we advertised for eight or nine recent graduates in the last round and we got several hundred applications and we were able to winnow that down to seven or eight very good people. So there is no question that there are a lot of earth scientists being produced. That is not to say there is an over-production because I do not think every earth scientist has to become a geologist, there are other things they can do. The quality of them overall is good. The one area where we do not believe the universities are able to quite produce the people we need is the fact that graduates these days have a more limited opportunity for field work, and this is partly the consequence of financial constraints and the size of class and these sorts of things, so regrettably they do not necessarily get all the field experience.

187. But do they have the mathematic competence required? My memory of doing geology at university was that the geology was fine but often you needed more geophysics or mathematical knowledge and I wondered whether there was any deficiency there or whether that is perfectly okay?

(*Dr Cook*) No, it is not as good as we would like. I think it is fair comment to say that we would like to have people with a greater level of competence in the hard sciences, if I can put it that way.

Mr Thompson: This is an issue separate from this Committee, it is a big issue for the country and I could spend a long time pursuing it, but I will not. Thank you.

Dr Bray

188. You are familiar with the organisation of the Oceanographic Institute at Southampton which works very closely with the university?

(*Dr Cook*) Yes.

189. To the extent that students spend their third year in the Institute working on their programmes. That goes somewhat further than the arrangements between BGS and Edinburgh and your own arrangements at headquarters. Do you see advantages in moving in the Southampton direction?

(*Dr Cook*) I am keen to see closer links with universities. We will continue to build on those and the fact that we are where we are geographically, a few miles away from the nearest university, is a problem to us at Keyworth. It is not a problem in Edinburgh, they do have close physical links and this helps, there is no question about it. I would have a problem with changing the organisational arrangements so we became part of a university. I think there would be mission drift on the part of the university and mission drift on the part of BGS if that were to happen. In addition, if we were to link in with one university we would perhaps lose the national approach that we have; we would be seen to be part of one university, whereas at the present time we have co-operation with just about every university in Britain.

190. You have already been asked about data collections and specifically about borehole and seismic data arising in the hydrocarbon field. There are no legal requirements on the oil companies to lodge their borehole data with the BGS, rather the Petroleum (Production) Regulations make it a condition of granting a licence for the licence holder to provide copies of the exploration data (borehole and seismic) to the Secretary of State for Trade and Industry. It is for the Secretary of State, if he so chooses, to make the borehole data available to the BGS. He has not so chosen, as I understand it, until the data is released from confidentiality, which is five years after its deposit and there is no agreed period for the release of seismic data. Are you happy with these arrangements as they now stand?

(*Dr Cook*) I have indicated on various occasions that I do not believe that the present arrangements are in the best interests of UK science or in the best interests of UK industry. I do not believe that it makes a great deal of sense to do it the way we are doing it.

Chairman

191. Does your board, which contains a number of industrialists, agree with that?

(*Dr Cook*) Yes, it does.

Dr Bray

192. And specifically the oil companies?

(*Dr Cook*) I cannot speak for the oil companies, Dr Bray, other than say that a number of them have indicated they do not believe that the present arrangements are entirely sensible. Perhaps one point I should make is that data such as seismic data you have mentioned is not just relevant to the oil companies, if it is on-shore seismic data it is also relevant to mineral companies, it can be relevant to hazard issues and things of that sort. What we would like to see is a one-stop shop for this sort of information, so that UK industry can get it from one place and that one place we believe should be the British Geological Survey. This is the situation in a large number of other countries.

193. Specifically that used to be the way it happened when the BGS was operating through the DTI?

[Dr Bray *Cont*]

(*Dr Cook*) We operated that core store on behalf of the DTI, but the DTI was still the owner of the data. There was actually a fairly high wall between that bit of the BGS and the rest of the BGS, but it was a little closer than it is now. It has now been taken over by contractors and we have little relationship with them.

194. Is this situation going to be lost irretrievably? Does the data actually belong to the private contractors now?

(*Dr Cook*) No, the data does not belong to the private contractor, it still belongs to the DTI.

195. So it is possible to correct the arrangements?

(*Dr Cook*) Yes, it would be possible to correct the arrangements. If there is a will to do so then it certainly could be done.

196. How long do the contracts run for?

(*Dr Cook*) I believe they are for five years and they have been running since 1993, so they have been going about three years and they have another two years to go.[4]

197. Have they said anything about the basis on which the new tenders would be arranged?

(*Dr Cook*) Not to my knowledge, no.

Sir Trevor Skeet

198. Dr Cook, would you not agree that a lot of this confidential information could not be disclosed to a central body for others to take from? On the other hand, the whole purpose of statistics is not to collect them but to turn them into profitable use. Have not the oil companies been singularly successful in discovering oil and if they want the information they have to drill for it which they then store themselves. Is it necessary to have any further information simply for the sake of a geological survey?

(*Dr Cook*) That is a fair question but let me answer it in this way. There is no guarantee that companies will exist forever. There is no guarantee that BGS will exist forever but we have a pretty good track record so far, and I am reasonably confident it will be around for a while longer. The point is that if a company goes out of business there is no reason for it to hand on its data to anybody else at that stage. People bring in a skip and throw it away because that is the cheapest way of getting rid of it. If the managing director or whoever has a conscience he might offer it to a university or to the BGS but there is no compulsion on him to do that, so you can lose a vast amount of data. The oil industry will eventually go away from Britain, or it will become a much lower key organisation as you deplete fields and so on, but that information is still highly relevant to understanding the geology of Britain and it may be that in 50 years time something which was collected by the oil industry is something very important for a resource we have not even thought of. For example, we may in a few years time be using anticlines for storing gases or something like that, for putting CO2 into for all I know. In other words, this information is very, very valuable for a long, long time; longer than the oil companies are going to be around. We have to regard it as a national asset and it has to be curated and kept with that in mind.

199. Yes, but you are not simply a museum. In 1964 we had the Continental Shelf Act which established the North Sea. Since then the oil companies have been very successful and they have been able to turn more money into the exchequer of the United Kingdom than I think any other agency. In that particular case, why the accumulation of information which *may* be of use? I can understand that under the North Sea there may be coal seams which you might like to hear about, but I dare say that information would be passed on to you voluntarily if you asked them.

(*Dr Cook*) There is a cost, of course, in curating information. It is quite an expensive thing to do so it is no good just receiving information if you do not have the funds to also store it and make it available. It is very important that it is made available. The information which has been collected so far by the oil industry is worth billions and billions and billions of pounds, there is no question of that, I cannot exaggerate the importance of it. You mention 1964 and it is very important to remember that the start of the UK oil industry really owes a significant debt to BGS, we did a lot of the early work and the advice we gave to the Government provided the basis for the first licensing round, the first leases, the first discoveries. So if you look at it that way, BGS has provided the underpinning for this industry which, as you rightly say, is worth a vast amount of money; I cannot remember what it is, probably 14 billion a year or something like that. It is that sort of order, it is worth a vast amount of money to the exchequer.

Dr Bray

200. Does the BGS still sit on those committees in the DTI which give allocations advice?

(*Dr Cook*) Yes. The contract we won was to provide geological advice, and that is a very important function. We provide that under contract to the DTI and we sit in on some of the licensing, yes.

Dr Williams

201. Why does the DTI take the view it does and when did the change take place?

(*Dr Cook*) Up until 1964 the BGS received by right under its initial Act all borehole information. I cannot remember the name of the Act, but when the 1964 Act which Sir Trevor referred to came into being it was decided that rather than that information going to BGS it should go to the DTI. My understanding is that a number of oil companies said at that time it should go to the Geological Survey, but the Department decided it did not want to take that route. It may have been concerned about confidentiality or something like that; it should not have been because we have lots of confidential information, but that may have been part of the rationale, I do not know, I cannot speculate on the reasoning for it. But it means at the present time we have rights to data out to the 12 mile limit, to the edge of the territorial seas but it ceases after that. Well,

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[4] *Footnote by witness:* We confirm that these contracts each run for 5 years.

[Dr Williams *Cont*]
that is, of course, a very arbitrary boundary from a scientific point of view, it does not make any sense from our point of view.[5]

202. So it goes back 30 years? It is not a recent change?

(*Dr Cook*) It goes back to 1964, that is when the Act was established.

203. In a sense that is the start of the exploration for oil and gas?

(*Dr Cook*) That is correct, yes. When the first licensing round was set up, the conditions were established under which the licences would be given out, and part of the condition was that the information acquired was given to the DTI.

204. Does this restriction on information slow down the exploration by other companies of possible new fields?

(*Dr Cook*) No, I do not believe it would do that, no. I do not believe it would slow things down. I am sure the DTI handle it in a very efficient manner.

Chairman

205. Does this kind of problem occur in other states where their surveys, assuming they have a not dissimilar national survey, do not have the full data available because of constraints on the use of data by industrial companies?

(*Dr Cook*) I cannot speak for every country. The country I know best is Australia and there the national survey has full access to the confidential information off-shore and in fact receives that information.

206. Is that under statute?

(*Dr Cook*) Yes, I believe so.

Sir Trevor Skeet

207. What about the USA?

(*Dr Cook*) The US is very complicated because of the state and federal issues. That is a much more complex situation and the USGS does get a lot of the information beyond the territorial seas but I am afraid I cannot comment on the nature of the agreements.

Chairman

208. Is the data contained actually covered by intellectual property rights in some way?

(*Dr Cook*) There are confidentiality clauses in the data on the release of the data, and so there should be. It is very important that confidentiality is maintained because this is what gives oil companies the edge and it would be unreasonable on anybody's part to expect them to spend hundreds of millions of pounds and then give that information to everybody else who wanted it. They must maintain that confidentiality.

Chairman: Understood. Dr Cook, thank you very much for your time and for answering our questions. We are very glad to hear so much about the British Geological Survey and we congratulate on what you are doing for them.

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[5] *Footnote by witness:* Clarification of Acts of Parliament giving BGS rights of access to geoscience information collected by industry: Provision was made in the Mining Industry Act 1926 for the mandatory notification to the Geological Survey of all boreholes to be sunk in excess of 100 feet (approx 30m) for the purpose of mineral exploration. The act also provided the Survey with rights of access to records and representative samples from such boreholes. This legislation is fundamental in ensuring the deposition of geological and associated data from these sources into the national geosciences database managed by BGS. The Petroleum Production Act 1934 defined petroleum as a mineral under the terms of the 1926 Mining Industry Act and the Geological Survey's statutory rights to borehole information were thus extended to include onshore hydrocarbon boreholes. The Water Act 1945 and the Water (Scotland) Act 1946 made similar provisions for water wells and boreholes of 50 feet (approx 15m) or more in depth. In 1965, the Geological Survey became part of the newly created Natural Environment Research Council (NERC). The Science and Technology Act 1965 transferred all the statutory powers described above to the NERC, although BGS remains beneficiary of these acts as an "agency" of NERC. The Petroleum (Production) Regulations 1966 and the Petroleum and Submarine Pipe-lines Act 1975 entitled the Secretary of State to furnish any of the data ("records, returns, plans, maps, samples, accounts and information") from hydrocarbon exploration and production within Great Britain or its designated offshore area, "to the Institute of Geological Sciences [now BGS] and to any body of a like nature as may from time to time be carrying on activities of a substantially similar kind to the geological activities at present performed by the Institute of Geological Sciences." The Petroleum (Production) Regulations 1982, and the Petroleum (Production) (Landward Areas) Regulations 1984 later substituted "NERC" for the "Institute of Geological Sciences" in these clauses. NERC (and hence BGS) access to geological data arising from UK hydrocarbons exploration, whether onshore or offshore, is now entirely at the discretion of the DTI.

WEDNESDAY 13 NOVEMBER 1996

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste	Mr Andrew Miller
Dr Jeremy Bray	Sir Trevor Skeet
Mrs Anne Campbell	Mr Patrick Thompson
Dr Lynne Jones	Sir Gerard Vaughan

Letter to the Clerk of the Committee from Dr Paul Mason FRS, Chief Scientist, Meteorological Office (14.9.96)

I am writing as Chief Scientist of the Meteorological Office to make a submission to the forthcoming inquiry on the Natural Environmental Research Council.

The Meteorological Office provides UK government, the public and many other specific customers with a range of services based upon atmospheric and related science. These include a wide range of weather forecasts, air pollution forecasts and advice on climate and climate change. In these services the Meteorological Office is acknowledged as an international leader and, status aside, the real benefits are the high standards of forecasts and advice which allow best guidance to UK activities.

It is no small achievement for the UK to have achieved such standards and the result derives from both the work within the Meteorological Office and the support through the science base of the NERC community. The University work in atmospheric sciences although relatively small in scale is nevertheless recognised as world class in terms of its achievements.

For the future we aim to improve weather forecasts in accuracy with the current 24 hour forecast accuracy being achievable for 48 hour forecasts in a decade's time. There are also prospects for seasonal forecasts and of course more precise and reliable prediction of climate change for planning purposes. If the Meteorological Office is to succeed in these goals then it is vital for NERC to continue to give due support to atmospheric sciences with matching attention to other critical areas such as hydrology and oceanography. As an end user of NERC atmospheric science activities and, with due note of benefits to the UK and the community, we believe they should have improved support particularly for observational work.

Memorandum submitted by The Meteorological Office (16.9.96)

NB The Science and Technology Committee raised a number of specific issues that it wished to be addressed. To guide the Committee, these are incorporated (italicised and in brackets) at appropriate junctures in the text.

1. INTRODUCTION

The Meteorological Office became a Trading Fund in April 1996. We remain, however, firmly within the public sector and run as an efficient, responsible and responsive, customer-focused organisation. We aim to provide a public service whilst maintaining and developing our international reputation as a world-class provider of meteorological services. We also remain an integral part of MoD and will continue to be the prime source of meteorological, climatological and related services for the Government, the armed forces, the public, aviation and commercial customers.

The market for specialised meteorological products and services, including climate-related advice, is increasing in volume and incorporates improved quality (accuracy and sophistication) as more businesses and organisations become aware of their dependency upon meteorological factors for safety and economic success.

The Meteorological Office is recognised as a world-class, science-based National Meteorological Service. A key priority is to utilise all our resources and expertise efficiently through the effective application of scientific research, technology, best business practice and continuous improvement of our performance. We have our own, independent numerical weather prediction (NWP) model and associated information technology facilities and underpinning research and development capability, to maintain this world-class status and to provide the full range of services required by our customers. Our aim is to capitalise on best practice and advice from inside and outside the Office and, in particular, to use national and international collaboration to maximum effect.

2. The Meteorological Office's Research and Development Programme

(What research does the Meteorological Office conduct itself, particularly into areas associated with global climate change?)

The Meteorological Office delivers to its customers a wide range of services based firmly on atmospheric and related sciences. These include a variety of weather, air-pollution and ocean forecasts. Advice is also given on climate and climate change. In all these services the Office is acknowledged as an international leader.

Our Research and Development (R&D) Programme has the sole aim of improving and developing the services offered to meet out customers' requirements. The costs of our R&D activities are met primarily through contracts with the Office's main customers. We also receive a limited, but significant, amount of funding from other customer-specific contracts, in particular from the European Commission. Such activities are also limited to work of benefit to the Office's services. The Meteorological Office is a direct funder of R&D to a very limited extent, viz., by sub-contracting and support of research studentships.

The main components of the Meteorological Office's R&D Programme are:

(a) Core Research & Development Programme

(b) Public Meteorological Service (PMS) R&D Programme

(c) Department of the Environment (DoE) Climate Prediction Programme (CPP).

Each of these is dealt with in turn and in more detail in Sections 3–5. The related contract income (ex-VAT) for 1996–97 and its sources are:

Core R&D Programmes	Core Customer Group (MoD, DoE, CAA, OGDs)	£9.6M
PMS R&D Programme	MoD (Chief Scientist)	£2.8M
DoE CPP	DoE	£8.0M
	Total	**£20.4M**

In response to a recent NERC survey (Analysis of Spend on Environmental Science, April 1996), we submitted the following breakdown of our R&D spend in the above programmes according to classifications of "Issues and Science Areas" provided by NERC:

Environmental and Natural Resource Issues	
Global Change	£10.15M
Pollution	£0.65M
Science Areas (interpreted by us as complementary to the above (and other) issues)	
Atmospheric	£8.33M
Earth Observation	£0.30M (in the R&D area)
Marine	£0.80M
Polar	£0.16M
Terrestrial & Freshwater	£0.01M
Total	**£20.4M**

In order to fulfil the above functions, it is necessary to maintain state-of-the-art models of the global atmosphere and global ocean, together with techniques for processing observations and "assimilating" them into the models. The Office's policy (unique among major meteorological and climate laboratories), which was initiated in 1990, is to use a single, so-called, "Unified Model" suite for all our forecasting and climate applications. Maintenance, development and improvement of this suite are major tasks, but having a unified model reduces our overall costs. All institutes involved in improving weather forecasts and in climate modelling and prediction have to undertake work of this sort, and therefore international collaboration provides a substantial contribution towards maximising benefits and avoiding unnecessary duplication.

Computing power is also a key issue in providing the services required by the Office's customers and also for the supporting research. To accommodate our growing requirements for computing, the current Cray C90 supercomputer is in the process of being replaced by a Cray T3E Massively Parallel Processor. Under the terms of its Climate Prediction Programme contract, the DoE will continue to fund and have the use of 70 per cent of the new machine for their programme at the Hadley Centre (see below). The Met Office will fund and use the remaining 30 per cent in support of other customer requirements.

Within the Core R&D Programme, the focus will continue to be on providing improvements to operational weather forecasting and related services. This is in support of direct customer need for improved services and a growing requirement for full forecast automation.

As explained in more detail in Sections (4–5), our direct contributions to the understanding, monitoring, modelling and prediction of climate change are included in the DoE CPP and the PMS R&D programmes. Given the Science and Technology Committee's stated particular interest in the UK organisation of research into global warming, it is worth at this stage drawing specific attention to the key role of the Hadley Centre for Climate Prediction and Research which lies fully within the Met Office's R&D Directorate. This is an internationally recognised centre of excellence for the study of both natural and human-induced climate change. It was established in 1990 by the Met Office and the DoE, and represents a major commitment by the UK to the international effort to provide a proper scientific basis for the study of climate and climate change.

Under Trading Fund arrangements, scientists in the Hadley Centre are in fact engaged significantly in all the major components (ie Core R&D, PMS R&D and DoE CPP) of the Met Office's R&D Programme. The Office's policy of using its Unified Model as the modelling basis for its operational weather forecasting, ocean forecasting and climate studies has ensured strong dependency and synergy between these component programmes with ultimate benefit to all the customers concerned.

The Hadley Centre is fortunate in being part of the Met Office because it undertakes a wide variety of other scientific and technical development programmes to the benefit of climate research. In addition to the modelling advantages already mentioned, developments in the Centre also benefit from direct interaction with the experimental studies of atmospheric processes that are carried out elsewhere in the Office, in particular using the unique observational platform provided by the Meteorological Research Flight's C–130 aircraft. The Centre's climate data studies also benefit greatly from the Met Office's role as the National Weather Service, receiving and archiving routine weather observations and climatological messages. The Hadley Centre is therefore more fully integrated into and dependent on the wider Met Office activities and resources than is often realised externally.

The complexity of the scientific issues being addressed means that the Hadley Centre cannot work in isolation, and numerous links have been actively established with other research organisations, both in the UK and elsewhere. Some of these will be mentioned more appropriately later. However, for a more holistic and comprehensive overview of the Hadley Centre's current and planned research and recent achievements, the Science and Technology Committee's attention is drawn to a brochure, "The Hadley Centre", published in July 1996.

3. Core Research and Development Programme

The purpose of Core R&D is to conduct applied work directed at improving the accuracy of weather forecasts and the efficiency with which they are produced in order to satisfy customer requirements. This involves a number of major activities, each of which has the potential for significant impact. The effort invested in each research area is, not surprisingly, approximately in proportion to the expected benefits.

The main elements of this programme are:

(a) *Use of satellite and other data*

Satellite data are essential to current performance and although there remains a large potential for further exploitation, this is not easy to achieve. Our effort is aimed at keeping abreast of international developments and doing a limited amount of original work only where we believe we are well placed to achieve a good return on our investment.

(b) *Data assimilation*

Observations of the atmosphere are diverse in character and not regularly distributed in time or space. Deducing the most accurate initial state for the operational weather forecasting model involves using a highly sophisticated technique ("data assimilation") which involves blending all available observations with a "first guess" based on the latest model forecast. Current operational data assimilation methods are not optimal and other techniques indicate potentially large benefits. Most research in this important area has been done in the USA, France and the European Centre for Medium-range Weather Forecasts (ECMWF). Our own effort is based on imported research results.

(c) *Improved representation of physical processes*

Good representation of a wide variety of atmospheric physical processes is essential for any worthwhile numerical model used for operational weather forecasting, or, for that matter, climate modelling and prediction. These processes need a great deal of attention because of their importance, the large variety that needs to be represented, and the need to "tune" some of the processes in relation to the overall model errors. This complex area provides a particularly good example of where, through our own research efforts, we can both contribute to and exploit the substantial international collaboration in meteorology. Wherever practical, significant elements of our models are simply imported, thereby avoiding independent research. Our own targeted efforts in this wide field are concentrated on aspects of: cloud physics, radiative transfer, convection, the atmospheric boundary layer, and flow over orography.

(d) *Dynamics*

The representation of weather systems in the models depends, among other things, upon both model resolution and the numerical techniques used. To be successful requires a numerical scheme which is free of inherent weakness and is capable of producing the correct behaviour. Weather prediction is computationally very expensive and our efforts here are concerned to ensure best use of computer time. This has long been a recognised feature of the Met Office's operational weather forecasting models. Current effort in this area is aimed mainly at implementing improvements based on our evaluation of outside advances.

(e) *Observational facilities*

Research advances in meteorology cannot be based entirely on theory. Major aspects of the science, in particular those involved with atmospheric processes, are strongly dependent on observations. Notable examples include: radiative transfer within clouds; the properties of clouds; processes involved with precipitation and turbulence. If we had no independent observational capability the scope of our work would be limited to often poorly available data from other centres and particular issues of concern to the UK and our models would be harder to address and resolve. Use of the Meteorological Research Flight's (MRF) comprehensively-instrumented C-130 aircraft, based at RAF Boscombe Down, Wiltshire, and our tethered-balloon facility at Cardington, Bedfordshire, are therefore essential to our plans and progress—at least up to 1999. From 1999, more limited access to instrumented aircraft has had to be accepted as a significant cost-saving measure adopted prior to our transition to a Trading Fund.

Note that all our R&D efforts under this contract are applied. We depend very much upon the more basic and strategic research that, necessarily, has to be done elsewhere, both in the UK and further afield. To this extent, we are dependent on NERC's support of basic and stategic research in atmospheric and related sciences in both its own institutes and, in particular, in the Universities.

In this context, a key issue in our future interactions with NERC concerns national observational facilities, such as the instrumented C-130 aircraft mentioned above. Observations of the atmosphere are essential to make progress in all categories (applied, strategic and basic) of atmospheric research. The Government expenditure cuts imposed on the Office prior to 1994 and prior to our transition to a Trading Fund Agency mean that the future of the C-130 aircraft beyond 1999 now depends critically on achieving a wider use and funding involving the NERC and other participating organisations, including the Defence Evaluation and Research Agency and the European Commission.

4. PUBLIC METEOROLOGICAL SERVICE R&D PROGRAMME

The Government requires advice from the Met Office on a wide range of environmental issues, many of which are controversial and demand immediate, informed and authoritative responses, in the national interest. In order to serve such needs effectively, a base of scientific and technical expertise is maintained. The applied and strategic R&D motivated by such requirements has traditionally also underpinned the Met Office's operational and emergency services provided for the public good and is, therefore, designated as part of the PMS. Recent issues have included: nuclear winter; acid rain; ozone holes; global warming; the Chernobyl incident; and the possible global climatic consequences of the flaring of the Kuwaiti oil wells during the Gulf War.

The PMS R&D programme is directed at underpinning and maintaining the Met Office's capability to provide advice on:

(a) *Atmospheric composition*

The aim is to maintain and develop expertise in atmospheric-chemistry modelling and in the chemical composition of the atmosphere, in order to provide a quantitative understanding of, and be able to respond quickly and with authority to, questions involving, the distribution, fate and behaviour of naturally occurring and man-made trace gases and aerosols throughout the atmosphere. Our main activities are the development of world-class models of atmospheric chemistry and their use to provide authoritative assessments and advice concerning atmospheric composition to Government and regulatory bodies. Current examples include, urban air-quality issues, stratospheric ozone depletion, particularly in the polar regions, and related ultraviolet radiation levels at the ground.

(b) *Atmospheric dispersion, including responses to nuclear and other emergencies*

The aims are: to maintain a responsive knowledge base for the provision of advice in emergency or regulatory contexts; to ensure that the numerical models used are of good international standard; and, to direct the work towards the improvement of emergency response facilities, such as nuclear accident response procedures, or other facilities maintained in the public interest, such as urban air-quality forecasting models. Our activities provide support for specific projects aimed at improving the availability of fast, reliable, high-quality information to Government decision and regulatory machinery. The main objectives are: the development and improvement of emergency response dispersion modelling systems, able to simulate the national and transnational dispersion of pollutants including radio-nuclides; to carry out necessary research on techniques to represent the deposition of pollutants and radioactive material to the surface, and chemical and photochemical reactions taking place in air, in numerical models; to increase our understanding of the meteorological factors involved in chronic pollution problems such as acid rain and poor air quality; and, to provide support for, and collaboration with, the Chemical and Biological Defence Establishment in the development of the dispersion modules of tactical decision aids and models for use in emergency situations (and also for MoD battlefield use).

(c) *Natural climate variability*

This activity aims to help meet the requirements of the Government and the Public for advice on climate and its natural variability. Specific objectives are: to monitor climate variations and trends; to identify and understand the causes of the natural variability of the climate system on seasonal to multi-decadal timescales; to determine the predictability of aspects of the climate system with a view to developing skilful seasonal forecasts, in particular, and if feasible, for Europe; and, to analyse climate data in support of these objectives.

(d) *Understanding and modelling climate*

This activity aims to help meet the requirements of Government and the Public for advice on current climate as influenced by natural events and human activity over the last century or more; and, future changes in climate and related areas such as sea level and water resources and their sensitivity to future energy and other policies. Particular objectives here are: to develop, maintain and apply state-of-the-art atmospheric, ocean and fully-coupled atmosphere-ocean general circulation models (AOGCMs) which give improved simulations of present climate and allow a much wider range of climate forcings to be represented; to demonstrate the degree of reliability of such models in simulating present-day climate, climate variability and change; and, to apply such models to specific problems of the type just listed.

The Met Office maintains an active programme of R&D in global ocean and sea-ice modelling and coupled AOGCM studies under both its PMS R&D and its DoE-funded Climate Prediction Programme (next Section). Indeed the UK lead on this was taken by the Met Office early in 1980, with the initial model code imported from the USA. By 1986, we had achieved the UK's first fully-coupled AOGCM. Although NERC developed an interest in ocean modelling in the early 1980s, its initial efforts were not motivated by the same practical goal of achieving a fully-coupled AOGCM for studying the global climate system. NERC launched its first global ocean modelling Community Reseach Project, OCCAM (Ocean Circulation and Climate Advanced Modelling), in 1992. The Met Office's Hadley Centre was one of only four institutes in the world to have completed so-called "transient" climate-change experiments by that time with coupled AOGCMs. It is important to realise the significance of the climate-related elements of the PMS R&D programme to the Office's and, indeed, the UK's, ability to undertake and deliver on the DoE-funded Climate Prediction Programme which was initiated in 1990. Because of this effort, the Met Office was the only UK institute to have already developed, tested and applied a fully-coupled AOGCM suitable for climate modelling and climate-change studies.

5. DoE CLIMATE PREDICTION PROGRAMME

DoE funds a Climate Prediction Programme (CPP) at the Met Office's Hadley Centre through a three-year rolling contract which is updated annually. This builds on the climate investigations undertaken as part of the PMS R&D programme. The requirements of this contract are motivated by DoE's needs in relation to the 1992 United Nations Framework Convention on Climate Change (FCCC). Key aims are:

(a) To maintain the Hadley Centre as a world-leading institution in order to provide the Government with the most up-to-date advice on all aspects of natural and human-induced climate change;

(b) To provide the scientific basis for UK negotiations under the FCCC;

(c) To act as a national focus for climate-change research in the UK;

(d) To provide timely, authoritative contributions to international scientific assessments, including those of the Intergovernmental Panel on Climate Change (IPCC).

The principal scientific objectives of the current (1 April 1996–31 March 1999) CPP contract are:

(a) To predict to the year 2100 the global and regional change in climate expected from increasing concentrations of radiatively and chemically active trace gases and aerosols;

(b) To assess changes in climate and major climate sub-systems in the context of Article 2 of the Convention;

(c) To characterise and quantify the influence of human activity on global and, where possible, regional climate change (including the UK) using model simulations and appropriate in-situ and remotely-sensed observational datasets of climate variables;

(d) To maintain a state-of-the-art atmospheric general circulation model, coupled AOGCM model suite, and appropriate computing facilities;

(e) To manage the Programme, disseminate the results to DoE and other Government departments, the media and the general public, and to provide a national focus for relevant UK and international research.

6. THE TECHNICAL SUPPORT UNIT FOR THE IPCC WORKING GROUP I

Given the Science and Technology Committee's particular interests in the UK organisation of research into global warming and the work of the Intergovernmental Panel on Climate Change (IPCC), attention is drawn here to a specific task, funded by the DoE and undertaken at the Met Office.

The IPCC was established by the United Nations Environment Programme and the World Meteorological Organisation in 1988. Dr (now Sir) John Houghton (then Director–General, later Chief Executive, of the Meteorological Office), was chosen as Chairman (now Co-chairman) of The Science of Climate Change Working Group (ie Working Group I), and a small Technical Support Unit was established in the Met Office, funded by the DoE. This Unit moved into the Hadley Centre when it opened in 1990 and has been located there ever since. The first IPCC Science Assessment was published in 1990, two supplements were published in 1992 and 1994, and the second full Assessment was approved by IPCC in late 1995 and published in 1996. These publications have been accepted as the most authoritative reviews of the current state of knowledge about the scientific basis of climate and climate change and have had a major influence on the establishment of the UN FCCC and its subsequent deliberations. In particular, through the direct support and involvement of the DoE, they have had a major influence on the evolution of the Government's policies with respect to the Framework Convention and related matters.

The next full IPCC Assessment is scheduled for 2000 and a number of Technical papers and workshops are planned before then. The DoE continues to fund the Technical Support Unit at the Hadley Centre, on a specific contract which runs from 1 April 1996 until 31 March 1998. The aims of the Technical Support Unit are:

(a) To provide the scientific Secretariat for IPCC Working Group I and ensure that the work of the group is cost-effective and is completed on time, to a high scientific quality and according to IPCC workplans and rules of procedure;

(b) To prepare and publish comprehensive scientific assessments on the physical aspects of climate change which reflect the international scientific consensus.

The work programme and specific deliverables of this Technical Support Unit are determined by the requirements of IPCC itself, and, in particular, its Working Group I. Note that the Met Office also influences directly, and is influenced by, the work of the IPCC, as discussed in the next section. In the former context, it is pertinent to note that the Chief Executive of the Met Office is the Permanent Representative of the UK to the WMO.

7. Research Strategy and Planning Procedures

(Over what timescales are research needs assessed, how are they defined, and how is the budget for research into particular topics determined?)

The move to Trading Fund status in April 1996 caused the Met Office to review and change its procedures for determining the content and balance of its R&D programme, and the corresponding priorities, resources and budgets allocated to the specific topics within the programme. The actual programme for each of the main R&D areas defined above is arrived at following iterative dialogue and negotiations either directly with the external customers or with those within the Office who have the responsibility to provide the required services. Various formal and informal procedures and activities aid this process.

With a view to the requirements of our main customers and our professional knowledge of recent and anticipated developments in atmospheric, marine and allied sciences, we ourselves prepare internal, 5-year, R&D Strategy documents, which are reviewed and updated regularly. Such a document is an implicit requirement for the R&D input to the Office's 5-year Corporate Plan, which is updated each year. In turn, the Corporate Plan provides the basis for the Office's more detailed, annual Business Plan.

Particular arrangements are:

(a) Core R&D Programme: a detailed programme is produced annually based on a wider contract for Core Services agreed and funded by the Core Customer Group. To aid in the development and scientific appraisal of this programme, the Chief Scientist (also Director of R&D) in the Met Office has created a new Met Office Scientific Advisory Committee (MOSAC), whose membership is comprised entirely of external scientific peers with affiliations ranging from UK Universities, the European Centre for Medium-range Weather Forecasts (ECMWF), other European and the American Weather Services, and an independent scientific expert working in the USA. The MOSAC meets for the first time in November 1996, under the Chairmanship of Professor B J Hoskins FRS, Department of Meteorology, University of Reading;

(b) DoE Climate Prediction Programme: Since it started in 1990, this programme has been funded through a three-year rolling contract which is reviewed and updated annually. For a programme of this size and complexity, it is important that its content, progress and scientific quality and integrity are kept under continual review. To this end, the DoE has established a Science Review Group. It is chaired by Professor R J Gurney, Director, NERC Environmental Systems Science Centre (previously the NERC Unit for Thematic Information Systems), University of Reading. The Group comprises national experts in areas of high priority for the programme, including several from NERC institutes. Since 1990, it has met about twice each year to consider various parts of the CPP, and to discuss the programme's interaction with other national activities. In 1995, the DoE asked the Group to undertake a more thorough review of the scientific achievements of the Hadley Centre in its first five years, and to advise DoE on the future content of the programme over the period 1996–2005. This was incorporated into a wider international review, undertaken by external consultants (Smith System Engineering Limited, Guildford), which looked at issues such as value-for-money, provision of supercomputing services, dissemination of information and interaction with the research communities in the UK and elsewhere. The outcome of this review was very favourable, with the overall conclusion that "The Hadley Centre has admirably fulfilled its obligations under the DoE's CPP" (Smith report, 26 March 1996).

(What use is made of the work of the IPCC in formulating your research requirements?)

A specific requirement of the DoE CPP is that the Hadley Centre should provide timely and authoritative contributions to international scientific assessments, including those of the IPCC. The considerable support provided by the DoE for the Technical Support Unit for the IPCC WG I (see Section 6), and the fact that this is located in the Hadley Centre, also indicate the importance of IPCC activities to the DoE. A specific conclusion of the recent external review of the Hadley Centre was that it had succeeded in providing timely advice to Government, thereby allowing the UK to deliver authoritative scientific underpinning for negotiations at the first Conference of the Parties to the FCCC, and to contribute substantially to assessments of the IPCC.

Given the lead role in supporting the IPCC process by the DoE, it is not surprising that Hadley Centre scientists have made major contributions to all the scientific assessments of the IPCC since its creation. In consequence, the priorities for research that are proposed by the IPCC are influenced greatly by our own thinking and, in turn, are reflected to a highly significant extent in our own climate-related programmes. It should also be recalled that the IPCC conducts reviews, it does not fund nor carry out its own research. At an international level, the research requirements are co-ordinated and implemented in programmes such as the World Climate Research Programme and the International Geosphere-Biosphere Programme. Met Office scientists also play a significant role in influencing and developing appropriate components of these programmes whose priorities are increasingly compatible and consistent with those proposed by the IPCC and are reflected in our own climate-related R&D programmes.

A recent development has been the proposal (led primarily by the UK) for an integrating framework for international climate-related programmes. This is being developed under the banner of "The Climate Agenda". This is intended to encompass all the climate-related activities of the international organisations which implement major climate-related programmes, and to provide a unified structure for the future planning and funding of these programmes. The lead is acknowledged to be with the World Meteorological Organisation (WMO), but it is also sponsored by other United Nations organisations, in particular, the Food and Agriculture Organisation, the United Nations Environment Programme, the United Nations Educational, Scientific and Cultural Organisation and its Intergovernmental Oceanographic Commission, and the non-governmental International Council of Scientific Unions. All these organisations endorsed the Climate Agenda document in 1995. Whilst focused on how the programmes are designed to, and actually do, meet the needs of Governments in running national climate programmes and in participating in international climate-related conventions, the document also proposes how maximum synergy between existing and future international climate-related programmes should be organised.

The Chief Executive of the Met Office, Professor J C R Hunt FRS, has taken a leading role in the evolution of this proposal and its progress through WMO, at which he is the UK's Permanent Representative. Currently the member organisations are drawing up proposals for The Climate Agenda to be presented to an Inter-Agency Committee and then donor countries in 1997. If this fails, the previous risk of duplication in the programmes and fragmentation of funding will re-emerge;

(c) PMS R&D Programme: In order to meet this requirement the Met Office is tasked by the Chief Scientist (MoD), who acts as a surrogate customer for Government as a whole, to carry out appropriate scientific research in order to maintain the necessary knowledge base to provide advice on a wide range of topics. The first Programme of Work contains the aims and rationale for each component of the programme, with detailed workplans, products and milestones for the first year (1996–97) and outline workplans and anticipated products for the next two years (1997–98 and 1998–99). Most of the work under this programme is closely allied to that in the DoE Climate Prediction Programme. It is the intention, therefore, to use the same Science Review Group (see (b) above) to review both the DoE CPP and the PMS R&D programme. Also, like the DoE CPP, the PMS R&D programme will be re-negotiated each year with MoD, with a detailed description of the next year's programme and a broad agreement only of the programme for an additional two years.

8. FORESEEN CHANGES TO THE MET OFFICE'S R&D ACTIVITIES AND REQUIREMENTS

(Do you expect your research requirements, or the way they are fulfilled, to change in the short to medium term?)

Apart from the normal pressures, constraints and opportunities of operating the National Metrological Service as a Trading Fund in the public sector, we do not envisage any major changes in the short to medium term (ie 1-5 years) requirements for a Met Office internal R&D programme aimed at providing appropriate and cost-effective services to our full range of customers.

Weather forecasting will undoubtedly remain the dominant activity of the Met Office but growth in activities supporting oceanographic and environmental services is expected. Collaboration within Europe is expected to grow, based on the extensive network of National Meteorological Services (a point emphasised by the Public Accounts Committee).

The one notable challenge for us is to achieve our aim of retaining the C–130 aircraft in the face of substantial reduction in funding in 1999. As noted, this resulted from the MoD saving measures in the Defence Cost Study of 1994. We are seeking joint use of the aircraft with the NERC, the European Commission, MoD and other Government departments in the hope that such co-ordination of use and funding will enable retention of this valuable national facility.

9. CO-ORDINATION OF R&D ACTIVITIES

(What co-ordination is there between the Office and other Government departments with similar interests?)

(a) *Core R&D Programme:* This programme is designed to serve the needs of the Office's main departmental customers, and the Civil Aviation Authority, who require products from a wide range of weather forecasting and climatological studies. It is therefore tailor made to suit and meet the needs of such Government departments. The content of the programme is agreed and funded by the Core Customer Group which comprises representatives from the departments involved. This process has been aided by the creation of a so-called Meteorological Support Group (MSG) under the management of the Chief Scientist (MoD).

The Head of the MSG is the chairman of Core Customer Group meetings. In addition, there are other special arrangements for ensuring that customer-specific, departmental requirements are met in a cost-effective manner. This applies in particular to the Office's relations whith its parent department, MoD.

(b) *DoE Climate Prediction Programme and PMS R&D Programme:* As explained above (see section 7c), the Chief Scientist (MoD) acts as a surrogate customer for Government as a whole for the Office's PMS R&D programme. This is managed on his behalf by the Head of the MSG.

(Who takes the lead in co-ordinating United Kingdom research into global change?)

DoE takes the departmental lead in promoting research aimed at providing the scientific advice needed to support the UK's involvement in international policy negotiations on climate change under the 1992 UN Framework Convention on Climate Change. It also takes a similar lead in relation to the two scientific bodies which advise the Convention. These are the independent IPCC, established in 1988, and, more recently, the Subsidiary Body on Science and Technology (SBSTA), established under the Convention to provide policy-orientated scientific and technological advice.

In principle, overall national co-ordination for global environmental change (including climate change) is provided by the Inter-Agency Committee on Globe Environmental Change (IACGEC), responsible to the Office of Science and Technology. Its members are the Chief Executives (or Deputy Chief Executives) of the five Research Councils, the Chief Executive of the Met Office, the Director-General of the British National Space Centre, and the Chief Scientist of the DoE (who also represents other central government departments). It is supported by a secretariat in the UK Global Environmental Research Office, Swindon. An export panel established by IACGEC has just produced a report which proposes a UK National Strategy for Global Environmental Research. IACGEC has already provided a useful forum for developing the member Agencies' policies on the provision and exchange of data. It should also play a key national role in establishing the UK's response to The Climate Agenda (Section 7b).

The DoE CPP at the Hadley Centre is governed very much by DoE's policy requirements and influenced and modified by the state of the science and the IPCC reviews. The Hadley Centre programme has itself acted as a focus for other national and independent research programmes and has indirectly encouraged a degree of co-ordination, as well as collaboration.

In practice, much of the co-ordination to date has been self-imposed through the increasing influence of international research programmes, in particular, the World Climate Research Programme and the International Geosphere-Biosphere Programme, and the reviews of the IPCC. The problems and priorities exposed and articulated in such activities, and the need often to address these through international collaboration, have established a need for much more co-ordination of funding, resources and research activity at all scales. This has stimulated several nationally-co-ordinated contributions to specific components of the full international programmes. The NERC has been particularly successful in taking a UK lead in this respect and, no doubt, will have provided impressive examples already to the Science and Technology Committee.

10. COLLABORATION ON R&D ACTIVITIES

A key element of the Meteorological Office's R&D strategy, as reflected in our Corporate Plan, is to maintain and develop good collaborative links both in the UK and elsewhere. In particular we aim to:

(a) Use international collaboration to maximum effect;

(b) Encourage better Research Council support through lobby and collaboration.

Collaboration with UK and international scientists in climate-related fields of expertise is a strong and successful part of the Hadley Centre's programme. The complexity of the scientific issues being addressed means that the Hadley Centre simply cannot work in isolation, and numerous links have been forged with other research groups, both in the UK and world-wide. The Hadley Centre's main interactions within the UK are with other parts of the Meteorological Office, university groups and Research Council institutes, particularly those operated by NERC. One of the main conclusions from the recent (March 1996) Smith review of the Hadley Centre was that "The close interaction between the CPP, the wider scientific community and the DoE's policy context makes the Hadley Centre unique among the principal climate research centres".

In recent years, the Meteorological Office, including the Hadley Centre, has played a leading role in developing collaborations, and associated collaborative frameworks, in Europe, particularly with other National Meteorological Services. In addition to our support and influence on the European Centre for Medium-range Weather Forecasts (ECMWF), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency (ESA), we have been instrumental in also developing more recent collaborative frameworks such as the European Climate Support Network

(ECSN) and the European Meteorological Network (EUMETNET). We are part of the DoE's network for consultation on the development of the European Commission's Environment and Climate Programmes and have contributed to and benefited from collaborations within such programmes since they were introduced.

Meteorology, in particular weather forecasting, is founded and dependent on international co-operation, collaboration and co-ordination. To this end, the Meteorological Office has always played, and continues to play, an active role in the affairs of the World Meteorological Organisation, including its R&D activities, to ensure that its policies and practices are meaningful, effective and efficient. Our participation in, for example, the projects of the World Climate Research Programme and the lead taken in promoting the concept of the over-arching programme, The Climate Agenda, were detailed earlier.

11. Collaborations with the NERC

The Met Office values its collaborations and interactions with the NERC, its research institutes, and the wider research communities supported by the NERC. Some institutional links have been long-standing and productive. In particular, those we have with the Proudman Oceanographic Laboratory (now part of the Centre for Coastal & Marine Sciences (CCMS)), the Institute of Oceanographic Sciences Deacon Laboratory (now part of the Southampton Oceanography Centre (SOC)), the Institute of Hydrology (now part of the Centre for Ecology & Hydrology (CEH)), and the British Antarctic Survey.

More recently, particularly with the development of the Hadley Centre's programme and the introduction of new programmes and Centres by the NERC, these collaborative links have been extended to include, the James Rennell Centre for Ocean Circulation (now part of the SOC), the Plymouth Marine Laboratory (now part of the CCMS), the Institute of Terrestrial Ecology (part of CEH), the Centre for Atmospheric Modelling (CGAM; at Reading University), the British Atmospheric Data Centre (BADC; at the Rutherford Appleton Laboratory), and the Environmental Systems Science Centre (ESSC, formerly NUTIS; Reading University).

The Met Office and the NERC are also partners with the University of Reading in supporting a centre of collaborative research, the Joint Centre for Mesoscale Meteorology (JCMM) at the University. This began in 1988 as a collaborative venture between the Met Office and the Department of Meteorology at the University of Reading. NERC became a partner in 1989. Other university groups closely associated with the JCMM include, the Atmospheric Physics Group in the Department of Pure and Applied Physics at UMIST, and the Mathematics Department at the University of Leeds.

Agreements are also in place between the Office and NERC to facilitate the use of the Office's major observational research facilities, viz., the MRF C-130 aircraft and the unique tethered-balloon facilities of the Meteorological Research Unit (MRU) at Cardington. In the case of the aircraft, NERC established a liaison and flight support post at MRF in 1992. In the case of the MRU, NERC provided support for a part-time liaison post, based at the British Antarctic Survey in Cambridge.

At an organisational level, the Met Office has a strong tradition of active involvement on NERC science and grants committees, working groups, scientific steering groups, and scientific audits. The Chief Executive has just completed his term as a member of the Council and he is a member of the Atmospheric Science and Technology Board (ASTB; of which he was the first chairman). The Office provides further expert representation on the ASTB, the Polar Science and Technology Board, and the Earth Observation Science and Technology Board. NERC's first Programme Director of Atmospheric Sciences was a three-year (1987–89) secondee from the Met Office; now Director of the Hadley Centre.

In return, the Met Office has benefited, and continues to benefit, from the active involvement and influence of NERC institute and university staff on its key scientific committees, viz the Meteorological Research Sub-Committee, which was wound up in 1995 to be replaced by the Meteorological Office Scientific and Advisory Committee, and the DoE/MoD Scientific Review Group which deals with our climate-related programmes.

In the past the Met Office has placed contracts with NERC, primarily through its institutes or with scientists in NERC-related university groups. In the latter case, we have also sponsored jointly with NERC, on average, about five new CASE studentships each year since 1992; each studentship lasting, on average for three years. These have been spread over about a dozen different university groups. We have also traditionally supported the corresponding SERC (now EPSRC) CASE studentships. It should also be noted that many of our contracts to university groups have been done on a purely bilateral basis, with no involvement of NERC or other Research Council.

As a Trading Fund, the Met Office can only be a direct funder of science to a very limited extent. However, we do have a number of externally placed contracts and sub-contracts, some of which are either directly or closely associated with the NERC. We also expect to continue to support a number of NERC (and other) CASE studentships.

(What is the average length of contracts placed with the NERC? What is the longest contract placed last year, and what the shortest?)

In answer to the Committee's specific questions:

Over the last few years, the average length of contract placed with NERC institutes (including the SOC, CGAM and ESSC, which are closely linked to Universities) is about two-and-a-half years. In two instances (effectively now CGAM and SOC) new contracts have immediately followed expired contracts in the same general area. In these cases then, the effective average length of contract has been more like four-and-a-half years. The longest contract placed in the past year (up until the present) was three years and the shortest was one-and-a-half years.

The Office also places contracts directly with a wide range of University departments. The lengths of such contracts range typically from six months to three years.

12. Requirements And Prospects For Future Collaborations Between The Met Office And The NERC

The Met Office will continue to strive to improve the quality of its services to all its customers. In addition to anticipated improvements in the breadth and accuracy of our operational weather forecasts, there are also prospects for developing longer-range (including seasonal to interannual) forecasts, and more precise and reliable predictions of climate change. In pursuit of such goals, we will continue to establish collaborations with NERC institutes and others in fields of atmospheric science and allied sciences such as oceanography, hydrology and Earth observation. In particular, it is envisaged that the JCMM at Reading University will continue to receive our support and the existing NERC-related collaborations with the Hadley Centre will continue to evolve. An increasing use of the Met Office's Unified Model suite by the NERC-supported UK Universities' Global Atmospheric Modelling Programme (UGAMP), co-ordinated and managed from the Centre for Global Atmospheric Modelling at the University of Reading, could accelerate the development and improvement of the model for all its applications and therefore has the potential to make a significant contribution to the UK's capabilities for operational weather forecasting and climate prediction.

Of particular immediate concern to the Office, and the wider UK atmospheric sciences community, is the threat of loss of the C-130 research aircraft. Although recent years have seen increasing collaboration with NERC over access to and funding and use of the aircraft, its longer-term funding has not been secured. There remains a need to explore further the prospects and possibilities of maintaining this unique and valuable observational platform as a national facility.

Examination of Witnesses

Professor Julian Hunt FRS, Chief Executive, Dr Paul Mason FRS, Chief Scientist, Meteorological Office, and Dr David Carson, Director, Hadley Centre for Climate Prediction and Research, examined.

Chairman

209. Good afternoon. You are most welcome. You have already seen a copy of Sir John Houghton's evidence to us when he came last week, so we have had one session on these issues. However, we very grateful to you for coming here and to be able to have with you another session on this. The first question I would like to ask is how was the Climate Agenda actually set up? You had a lot to do with it. It is also intriguing to us to know how it actually arrived. It must be a difficult thing to get agreement on.

(*Professor Hunt*) First of all, thank you very much for inviting me and my colleagues here from the Met Office. We have been very interested in this inquiry into NERC, with which we have very close dealings. I was a member of NERC Council for two or three years. On the question of the Climate Agenda Conference, which was an Inter-Governmental Conference, held in 1993 one year after the Rio Conference. I led the United Kingdom so this was an inter-Governmental meeting. It was organised under the auspices of five United Nations technical agencies: the World Meteorological Organisation, the Intergovernmental Oceanographic Commission, UNEP, UNDP, FAO, and then the scientific organisation which is ICSU, the International Council of Scientific Unions. The idea was to review the whole work of the World Climate Programme, which is a whole set of programmes and which already involved a number of these agencies, but particularly then to consider whether the governments would maintain or increase their funding. The Chairman of the meeting was John Houghton. There were two Brits involved, myself and him. We did not see entirely eye to eye. He was rather hoping, if I may put it colloquially, that the governments would come along with their cheque books, but that was not the nature of the meeting. The meeting was really the view—taken certainly by the United Kingdom delegation, in which the Department of the Environment was involved—and many other governments, that this was premature. The fact was that it had somewhat grown like Topsy. There were many of these world climate programmes. There was overlap perhaps, some were forging ahead and some had just started. Clearly it was necessary to have some kind of review of all these programmes before it was reasonable for governments to take a position about the extended funding of them. Governmental agencies were quite vociferous in saying that they found it very confusing

[**Chairman** *Cont*]

to get the odd application for special funds from one UN agency after another, but they had no framework within which to do it. So I strongly supported the conclusion of the meeting, which was certainly not what was planned, that there should then be a review of the world climate programmes and activities, and there should be something that would then be agreed by all the relevant UN agencies. This would provide, this word which we developed later, the *framework* within which funding could be taken. I was, if I may so, very energetic about this, Chairman, and partly also through the good offices of Dr Mason who also saw sense in this. We found a bit of money to get some British consultants to start doing some work on this and this demonstrated its strength. Eventually we did, by 1995, get all the relevant bodies to agree to a single document or framework. The FAO, the Food and Agricultural Organisation, only gave an indication. In fact, we have just heard in the last month that their Council has finally approved that it would move ahead in this framework.

210. This was an internationally agreed framework or programme?

(*Professor Hunt*) Exactly.

211. Under your general auspices purely?

(*Professor Hunt*) The UN agencies responsible for the international climate-related programmes, including the World Meteorological Organisation, all the UN agencies and the International Council of Scientific Unions, which you must not call a UN agency because it is a body of independent scientific organisations. The plan is that 1997 is, as the Americans would put it, the put up or shut up year, as it were, when this whole programme will come together. It has been quite a difficult balancing act to keep them all going together, in which the proposal will be put to the agencies and perhaps some body of donor countries, funding countries, to look at this perspective and to say, "Is this the framework we now want on which to go ahead and to continue to support and develop the programme?"

Chairman: Thank you for that information of the genesis of all this. Dr Bray.

Dr Bray

212. Has there been any indication of the British Government's attitude in this, to this Agenda?

(*Professor Hunt*) As I said, the Department of the Environment were part of the delegation that got the ball rolling. The Department of the Environment were also part of the United Kingdom delegation at the World Meteorological Congress in 1995 keeping in faith with this idea. They are chivvying us at the moment to say, "Where are the papers for the meetings to happen next year for some decisions to be taken?" We find their goading quite helpful.

213. Are there any problem countries, the United States in particular?

(*Professor Hunt*) The United States were quite sceptical. This was perhaps not surprising since their Global Climate Committee has twenty agencies or something in the United States. But they have come on board on this and are strongly supportive. They have been at all the international meetings. I think that when there is a meeting next year, we will find that the United States Global Environmental Change Committee will be supporting this quite strongly.

214. Reading the Climate Agenda and hearing your description of how it has the support of the UN agencies, it does seem to be a far more clearly formulated programme of research than we have within this country. Is that right or not?

(*Professor Hunt*) No, I do not think I would agree with that. It was clearly one of the questions asked at the Inter-Governmental Committee in 1993, which countries could put up their hand and say, "We have a national climate programme." The United Kingdom were not able to put their hand up and, indeed, I certainly am not necessarily in favour of that. But we have national climate activities which I think are much better co-ordinated than those of most other countries. I see the comments of my predecessor, John Houghton, about that in evidence; and I see United Kingdom co-ordination through obviously more rose-tinted spectacles than he does. Through the leadership of the Hadley Centre, and this Inter-Agency Committee, and the involvement of NERC, we have talked together, even with the Government departments in the United Kingdom. It was a bit of a battle, I might say, but uniquely we all looked at these documents before they went to the UN agencies, and this is a bit of a first. They were actually singing from the same song-sheet when they went to the different UN agencies. That does not happen in any other country in Europe.

215. In terms of the results you want to achieve, all that matters is coherence in the final work actually done. On something like climate that is inherently an international problem. So the coherence is really more important at the international level than the national level, is that right?

(*Professor Hunt*) It is very important in both, but it is certainly very important internationally. Coherence is, if I may say, something one needs to be quite considered about. You can perhaps artificially go for excess coherence because climate is something that affects, is done by different organisations, governmental and non-governmental organisations, so I think they will co-ordinate in different ways. It will be done in a biological/chemical way or a meteorological way, and you want certainly to have co-ordination and you will have different customers. The customer of the IPCC is a major customer, but there may be other customers who will be interested in the practical commercial aspects. This is one of the fascinating features of this tapestry of the elements of the World Climate Programme, in that they are orientated towards different customer requirements coming from different physical groups. So one does not want to be too naive and say, "Gosh, this is a chaotic mixture," because there are all these different elements but we have got to get them all working together. It is a complex business but we are now attempting that.

Sir Trevor Skeet

216. There are three organisations which have responsibility for certain aspects of weather change; there is the Department of the Environment, NERC and the Met Office. Can you distinguish these responsibilities or are they triumvirate?

(*Professor Hunt*) Of course the Department of the Environment, sometimes in a slightly sophistical way, says they are responsible for anthropogenic climate change, and the Ministry of Defence is responsible for natural climate variability.

Dr Bray

217. Are you anthropogenic or natural?

(*Professor Hunt*) Well, you heard what I said. NERC, of course, is responsible for—I would say fundamental research—but which includes many areas involving biological and chemical research, which are outside that area. Of course they feed into climate prediction and, indeed, to the understanding of climate variability.

Sir Trevor Skeet

218. Surely, Professor, would it not be a good idea for NERC to assert responsibility more than it does? Should that not be conceded to them?

(*Professor Hunt*) I would disagree, Sir Trevor. NERC is a research organisation and I think it is very important for a research organisation not to be—I know this is not a very fashionable thing to say—but not be excessively goal orientated. It should be able to look at all sorts of possibilities. The Met Office is quite goal orientated, producing forecasts, which extend to seasonal prediction and climate prediction. The Department of the Environment advises Government about anthropogenic climate change and they should get research from wherever it comes. It would be a distortion of NERC's role to be given either a strongly operational or a strongly advisory role.

Mrs Campbell

219. But there is obviously some advantage in one body giving a clear lead on environmental change and being able to back it with sufficient budget as well. I think that is a problem when it is diversified among a number of different agencies. Would you not agree with that?

(*Professor Hunt*) I have defined how I see these roles and I believe that the degree of co-ordination has greatly improved. There is an intellectual basis for this co-ordination. It is not, "We have better committees and better chairmen." It is actually because we have got the very strong intellectual drive of global climate modelling so Dr Carson, who should perhaps speak about this, the Hadley model feeds in. Palaeobotanists, for example. It is extremely important to know how plants behaved thousands of years ago with a different outside environment. That is a way of testing global climate model. The climate modelling is this extraordinary intellectual binding force. I think this highly divergent, hopefully chaotic research in all these different areas by NERC is splendid. It is all feeding in. There is a jolly good interaction. I do not think I am really supporting you.

Chairman

220. A fertile operation rather than something to be structured? You like to see what turns up.

(*Dr Mason*) If I could add a comment. I think it is worth making some comment about how well the present arrangement does work because the Hadley Centre programme is the result of not just its own work but also the combined community work. The result is demonstratively one of the leading activities in the world. For that to be achieved by the United Kingdom community, within which I would say the application of resource is certainly by no means more than average, is actually a very significant achievement. I think one of the reasons it has happened is that we perhaps, more uniquely, have associated the actual climate prediction within the operation centre with responsibility for weather prediction models. The climate model itself consists, in its essence, of a weather prediction model run for hundreds of years to predict this climate biological variation. This arrangement is one that has been uniquely envied by others and one should think quite carefully about changing it.

(*Dr Carson*) I had the privilege of working in the NERC for three years between 1987 and 1989. I was the first so-called Programme Director for Atmospheric Sciences, on secondment from the Met Office. My chief role there was to help them develop their first strategy for atmospheric sciences. In that process I had then to try to look at the different roles of the different organisations, the different players in atmospheric sciences within the United Kingdom. Although I had some problems, I did not have any problem in seeing the different responsibilities. NERC has a different responsibility to the role of the Met Office. We are essentially an operational centre. We do research to serve particular customers. I did not find this as difficult as perceived by the panel. There is no difficulty determining the different responsibilities of the different organisations, they are essentially to do different tasks, in my view. Certainly when the Department of the Environment, at the request of the Government, saw the need to set up a climate prediction programme in 1990, the only establishment they could turn to in the United Kingdom at that time was the Met Office. We had a very long tradition and record of developing the basic tools. Whether these be numerical models or climate data, we had the basic tools in place already to address those very specific issues and produce timely deliverables for the Department of the Environment at that time. I think this is a role, now recognised as a public meteorological service role, that the Met Office traditionally always had. We are not simply the national weather service. We are the national Meteorological Office which has a much wider context.

Chairman: Fair comment.

Mr Miller

221. I want to move on to the membership of the Inter-Agency Committee, which seems to comprise of the Chief Executives of the five research councils, the Met Office, and the Director General of the British National Space Centre.

(*Professor Hunt*) And the Department of the Environment.

222. Yes. I want to pose the question to you, is this the right membership for such a committee? Earlier on, Professor Hunt, you quite rightly used the word customer; asking who the customer is. Is the committee too close to the paymaster? Should it be more independent? Could a better membership he devised in terms of the very important function that Committee has?

(*Professor Hunt*) That is a good and relevant question. It parallels questions which have just been asked by the Chief Scientist at the moment in some correspondence to members of the Committee, so I have thought a little bit about them and we have discussed them. Climate prediction has begun to be an activity that particularly business and industry is taking more and more interest in. Perhaps that might not have been the case five years ago. The case is coming for some representation of that. You could argue that the BNSC person from DTI wears that hat. The other feeling that we have is that now we have the Environment Agency, which of course has a very broad role—although the Department of the Environment is its responsible department—there would be a case for having the Environment Agency as a member and possibly MAFF. It is interesting that the Medical Research Council is a member and they come from time to time. The medical research aspects of climate are also beginning to be important. One of the measures of the initial success of the Climate Agenda activity is that WHO has now joined because they do see that. But I do think that customer dimension, user dimension of global environmental change is important.

223. So starting with a blank sheet of paper, you would not necessarily have the same make-up as you have now? Your definition of customer presumably would be partly private sector, partly academia?

(*Professor Hunt*) Yes, that is right. The question has been raised as to whether we ought to have some broader national forum for global environmental change which might meet on a different basis, where you would have a wider basis of business communities and academics, as well as the sort of governmental inner committee. There might be some advantages from time to time for the governmental bodies to discuss with each other, but a broader national global committee for environmental change research is something that was proposed by Professor Hoskins' committee which was meeting last year, and in a way it would then take over this Committee. There is a Royal Society Committee which has had some sort of role in that. It would begin to come closer to the idea of some national forum for environmental change research, which the IACGEC might move into.

Dr Bray

224. The position really has arisen as it has, in my view, achieving remarkable technical results in terms of the ability to see the weather and climate change, because there has been a hard technical core there which was developed in weather forecasting, extending to climate change, using the same disciplines, the same model, even the same computers. Now that maintained a coherence and providing you have that technical coherence, the supervisory structure in a way almost does not matter providing the technical core performs. The problem is with climate change—and especially measures to respond to the climate change—it goes into other areas which do not have as disciplined an integrated model there tying everything together.

(*Professor Hunt*) That is why I agree with Mr Andrew Miller. One of the things I have learnt in my job is thinking of customers as a form of intellectual discipline. I do not think I would have said that six years ago but it is actually—

Chairman

225. You have very intellectual customers.

(*Professor Hunt*) That is right, but the point being that once you have got customers for a business, it does pose interesting constraints and methods of working. Now that we are doing this business quite well, using the same models and this data—making seasonal forecasts in Africa and Brazil and next year for the United Kingdom—in fact it is a point made by the Department of the Environment, by Dr Fisk, that this capability will have a much wider variety of customers. Now that people are making reservoirs and want to make decisions based upon these calculations, as I say you have got the beginnings of a customer framework. I think a customer framework will provide a new framework for this wider area that you are talking about. It will not actually be so vague as perhaps you are implying. Surely you will still have the intellectual forum of Hadley modelling but there will be this wider framework.

226. The present arrangement has worked because of having stuck to a fairly narrow technique, I know, but if it is very much wider and there is not the integrated discipline of the model, then you really are into big trouble. Government itself has to be the wider body because it overlaps into so many aspects of foreign policy, defence policy and all the rest of it. Now to establish the intellectual basis of going for that further step, you have the advantage within meteorology of it having been done within meteorology. Who is doing it more widely? I do not see any signs.

(*Dr Mason*) I do not think there is a simple answer because as soon as you look to the climate impact community, it is, of course, diverse across all of the impact areas. There cannot, in a sense, be a coherent focus to impacts. They extend from vegetation through to the more human aspects of biology. In its nature I know the Department of the Environment sees it as one of our key responsibilities to take the output of that core modelling activity and increasingly put that into the impacts community. The development of the impacts community, as you suggest, is a critical issue for the future in this work.

[**Chairman** *Cont*]

It is a complex thing. I am not sure that the way forward is to form a central nucleus now because of the nature of the very diverse disciplines.

Mr Thompson

227. I think we are probably exploring the same area but just developing a little bit further forward. We have been hearing about how successful the United Kingdom has been, and is, in this area of research. Is it true that we are second only to the United States and do we, or can it be confirmed, that we do play a leading role in international negotiations? If so, how has this been achieved? The question that comes to my mind is that if you have really high quality research which we have been hearing about, when I was training in science many, many long years ago, I did not think about organisational structures. I thought about the leading scientists, the figures I looked up to, whoever they might have been, in physics or geology or whatever the subjects might have been; and I saw the really good research resulting from their work and their leadership inspiring the younger people to come on behind and do the research. So is our good position in this position due to factors like that, or has it been due to the way things have been organised which is what we have been discussing over the last few moments? What I want to know is how has our pre-eminent position been achieved, and what developments or choice of priorities in the future might enable us to continue that leadership? Are there any likely dangers on the road?

(*Professor Hunt*) May I give you an answer as an outsider having joined the Met Office, and Paul Mason will give you an answer as an insider who has spent his life in the Met Office. Comparing with the United States, the point is that in the United Kingdom very able people join governmental institutions—whether it is the Civil Service or the scientific Civil Service—the top, the best. That is something that is not the case—I was just talking to somebody from the United States weather service yesterday who is Argentinean—making that point. So we have that almost cultural benefit. Therefore, we have excellent people who have joined the service. Dr Mason was elected a Fellow of the Royal Society last year. He is an indication of somebody who joined the Met Office and spent his career there and is a very distinguished scientist. That is one thing. The other point is that you said it was either/or. I do not think it is either/or. It is a both/and point. We do have an excellent thing. It is also a very disciplined organisation. I am not sure this should be for the minutes, but the French Met Office regards the British Met office almost as a concentration camp because we are so disciplined. But it is a focused organisation and has very good people. In practice it is very exciting. In the Met Office you have got all this data and exciting events.

228. What dangers do you see lurking around the corner?

(*Professor Hunt*) Perhaps Dr Mason could answer both your questions.

(*Dr Mason*) Taking your original question, the answer is both. I do think that the UK combination of a more operational agency actually bringing together the ingredients which make the climate model work well. The important thing about a climate model is that it has lots of diverse science components which are the results of individual things. Within the Met Office we are fortunate in having a strong applied science edge, which is particularly critical in actually enabling us to make full use of what the research community in NERC, the universities and indeed the rest of the world do, because we obviously build what we do on the international as well as the national field of research. Having that focus within the Met Office I am sure has helped the research councils and the scientists within it. We have very active direct collaborations and personal links with those scientists, and they clearly gain considerably from that access in terms of the wherewithal it gives them to conduct their more basic research. The present arrangement does work well.

229. Do you see any dangers of what might happen, potholes which might be fallen into?

(*Dr Mason*) In these times of change we do have a viable working role at the moment. I think we are concerned to see us respond in terms of the challenges within the Climate Change Programme to necessary change. The scientific focus has to move so we cannot just rest on our laurels. We have to be vigorous both within the Met Office and outside the Met Office.

230. Internal vigilance.

(*Dr Mason*) Yes, but you have a community which works well on that basis. Our real concern is to make sure that in the nature of the split responsibilities the funding base remains coherent, because beneath those split responsibilities there is, of course, a requirement for a net resource.

Dr Jones

231. In your submission you were saying that because of your status as a trading organisation you are limited in the amount of original research that you can do. It is only when it is well placed to achieve good return on investment— You say how you depend very much on basic research being carried out elsewhere, particularly in NERC. In relation to the Hadley Centre, obviously there is a lot of co-operation with NERC. Is it really the right place for the Hadley Centre to continue to remain with the Met Office in view of your status? You have already mentioned the difficulties of decisions by the Ministry of Defence in relation to the C-130 aircraft. Has further consideration been given to this, and whether in the current situation with the whole issue of climate agenda being much higher up the political agenda, is that the right place for the Hadley Centre to be?

(*Professor Hunt*) You have rolled a number of issues. If I may pick one of them because I do want to put that very clearly on the table. The question of being a trading fund, I see being a trading fund— In some sense it is a technical term, I believe. One should regard the governmental framework as a technical term. It means that money is given out centrally on a vote-funded basis and given to all the various customer departments. The Met Office was doing work for many other Government departments but funded by MOD. Now these Government

[Dr Jones *Cont*]

departments have got some of the money and pay us directly so we are focused on contracts with those customers. Therefore, it actually has a very great discipline on the Government departments who are working with us, as much as it has on ourselves. The fact is that one of our largest customers is the Civil Aviation Authority. It is United Kingdom policy at the highest level, as far as I can see, of the trading fund; that the United Kingdom Met Office should remain a world area forecast centre for aviation. We will only be that if we are very close to the best in the world. There is, as it were, a commitment by a variety of central Government departments to maintain this level of excellence and, therefore, the level of investment in computers and so on which is absolutely essential for the question of global climate change research. So it is this synergism and commitment to a high level of investment and excellence that has been committed. Also, that the level of technical return on capital is of the high level to enable us to maintain this investment. Your question was whether somehow—

232. It does not sound a very high level of commitment, the C-130 aircraft.

(*Professor Hunt*) Dr Mason will talk about the C-130.

(*Dr Mason*) Could I speak specifically about the C-130. The annual cost of running the C-130 constituted nearly 50 per cent of the total cost of research in the Met Office. The cost of the aircraft, all of that cost was borne prior to the trading fund outside the Met Office's funding base by the Ministry of Defence. In 1994 there was a defence cost study seeking means of reducing the cost of the defence budget. That reviewed the future of all aircraft within the Ministry of Defence. It made a specific recommendation for the C-130. It recognised that whilst it was important to meteorology, it found it hard to justify at that cost level which was so large in relation to the rest of the programme. It actually set us not an immediate withdrawal of the C-130 but a challenge which, in a sense, we simply carried through into the trading fund. It is not, in itself, to do with trading fund status at all. In our costing profiles at that time they reduced funding available to the aircraft from the original figure down to a figure of approximately one-quarter by 1999; the one-quarter figure, providing the Met Office with the wherewithal if all else failed, to provide some external access to aircraft. The recommendation of the defence cost study was nevertheless that the Met Office should try, noting the wide use of that aircraft, to look to the United Kingdom community to see whether rather than us simply buying time on another aircraft, there was a possibility of having the C-130 as a national facility run under joint funding. At this point in time we do have paid usage by the research council, NERC. We have a measure of funding from the European Union to allow other countries to have access, and some prospects of further use outside meteorology by the Ministry of Defence; the total of which does actually give us some hope—although I cannot say it is a definite commitment—that the aircraft may continue to exist past this difficult date when our funding finally reduces. It does have a little to do with the trading fund, but it is more to do with the Ministry of Defence itself just being concerned not to be bearing on the defence budget costs, which were larger than they ought to be in relation to the Met Office needs.

Chairman

233. I assume, Dr Mason, that your role—your role as well, Professor Hunt—as one of the world leading authorities in relation to aviation, in relation to aircraft movements and cloud and that kind of thing, would not be able to continue had you lost the use of that facility?

(*Professor Hunt*) The answer is that this aircraft is useful for looking at fundamental processes, particularly in cloud physics, so the answer is that it is an important part of our research programme to maintain this level of excellence. As Dr Mason has said, we would use our funding to gain access to this information in other ways. I certainly would not—and the Ministry of Defence would not regard that—as being the cause for losing that particular facility.

(*Dr Mason*) We assess the return we get from our research. The return we get from the aircraft, whilst being valuable, is not in proportion to the full cost of the whole aircraft. We feel we will get a just return from approximately a quarter of an aircraft, and that is part of the rationality behind the Defence Cost study. It is fair to say that fortunately there is free exchange of intellectual property in meteorology and the beneficiaries of the aircraft are global, they are not just ourselves; so in a curious way our position in the area forecasting centre is not dependent on the aircraft. What you would damage with the loss of the aircraft is the whole global community, not just ourselves.

Mr Thompson

234. Do you think that the United Kingdom gives sufficient priority to observational requirements, and what kinds of observational requirements are we talking about?

(*Professor Hunt*) The C-130 observational requirements are in the context of research. Our main emphasis in observations is to maintain the regular level of information daily for weather forecasting but also for climate. We have certainly found efficiencies in that area in the past few years and expect to continue to do so. Technology is helping us. The United Kingdom through its satellite programme, which is now going to be funded partly by the Ministry of Defence, is going to be making a very major contribution to the measurement of the world climate system through the investment of particularly METOP, a set of three satellites. We have done a comparative study of the number of contributions to observations compared with other countries of Europe on GNP on an area basis and we come somewhere in the middle.

(*Dr Mason*) I should perhaps add that in relation to the letter I wrote, that we do have a concern on the research side that the research councils—perhaps somewhat in the nature of them needing the output which seems to be directly focused on customers in the applied sense—have shown (to us at least) an increasing tendency to neglect some of the basic research which often involves observations upon

[Mr Thompson *Cont*]

which we depend ultimately for progress, and sometimes to concentrate on the near application developments. Clearly I do not think things are far wrong in that area because obviously we have good contacts with the research councils, but we have reached the point where we have felt it necessary to express caution that they should not continue to drift in that direction.

(*Dr Carson*) If I might return to addressing the issue of trading fund *vis a vis* climate change, and if I can refer back to the question asked by Mr Thompson; in the context of the type of work done at the Hadley Centre, we should make no mistake, we are second to no-one. The way the question was put was that we might be second to no-one but the United States. I am sure that our counterparts in the United States would concede that in that particular area we are second to no-one. We are certainly one of the leading players in the world. Again, I think this was partly due to a long and strong tradition of atmospheric sciences and climate modelling within the United Kingdom, and also the organisation and the way the new Department of the Environment contract on climate change was organised. Returning to Dr Jones' question, in that context the Hadley Centre was operated as a trading fund right from the word go with respect to that climate prediction programme. We have been on a fixed period contract from the Department of the Environment since the start of its Climate Prediction Programme in 1990.

Dr Jones

235. £8 million.

(*Dr Carson*) It did not start quite as high as £8 million but in recent times it has been £8 million or so a year. At any given time we have a three-year contract which is renegotiated annually. So far it has rolled forward an extra year every year. We have a very intelligent and increasingly intelligent customer in the DoE. Where I think we differ from other climate modelling centres and other climate prediction centres is that there is a very strong link and focus. We are there primarily to advise our Government. We are not an academic institution in our own right.

Sir Trevor Skeet

236. May I make one point here. One continues to refer to the pre-eminent position one holds in climate research. All expenditure has got to be paid for and we have already been told that NERC contributes something; the Ministry of Defence foots part of the bill; and the European Union comes in. What are the proportions for each? Can you expect more to come from the Community than you have had in past years?

(*Dr Carson*) Again, purely on the work done on climate in the Hadley Centre, this year the income from the Department of Environment for its Climate Prediction Programme, which is on contract, has been £8 million this year. That is income. All these figures are ex-VAT. The contribution from what we call the Public Met Service Research and Development Programme, which is sponsored essentially by the Chief Scientist of the Ministry of Defence as a surrogate customer, the amount from that which is directly attributable to the Hadley Centre is about £2.2 million. In relation to that programme, this year we are also bringing in about three-quarters of a million pounds from the European Union. Now one of the questions asked earlier was where is the threat to something like that? I personally can see no added value in the Hadley Centre being in any other organisation, including the NERC, within the United Kingdom. This is the best I can judge, at the present time, from what we have achieved in six years operating as the Hadley Centre. The obvious threat to us is that if any of those funding lines, in particular, the two governmental funding lines, change significantly, this will clearly pose a direct threat to what we are capable of doing.

Mrs Campbell

237. I would like to get on to the thorny subject of finance. The Climate Agenda is calling for a substantial increase in expenditure on observations of the atmosphere. Can you convince us that this expenditure is necessary, and how you are going to persuade individual governments or international organisations to provide that?

(*Professor Hunt*) It is quite interesting, if I may say so. I came into my job following a very major suggestion of a massive leap forward in expenditure on observations by John Houghton. I could see also that financial writing on the wall rather like you are talking about. However, I could also see that there was already in the pipeline a very significant growth of expenditure already planned. Just to come back, the United Kingdom is likely to be agreeing—perhaps at the end of November next year—about its contribution to this meteorological satellite programme, which would be rising to £200 million. This would be an enormous contribution to atmospheric observation, both to meteorology and climatology and so on. My concern is, in fact, that this existing investment programme is not particularly well bedded into the research community. It is not going to be utilised sufficiently well. It is absolutely imperative that the investment programmes that we already have are very well used by its scientific community. We did a study last year of how many British institutions would make use of this data. We, and the BNSC, were rather disappointed to find that out. So this is an example of where existing investments, which are already very substantial and already in the pipeline, could make use of this relatively limited expenditure at the international co-ordination level. That is what we are talking about. It is always very difficult when you are talking about international funding, whether you are talking about the committees in Geneva, or whether you are talking about the total activity around the world. One of the things is that with the IPCC quite a few people, quite a small number of people, have been very effective in that area. That is the case with the Climate Agenda. If we can get this information flow—some of it might be data from Africa which is sitting there and not coming out; also data should be going in with seasonal forecasts and satellite

[Mrs Campbell *Cont*]

information—there is a great deal of material and effort that does need co-ordination through all these different agencies to make very good use of it.

238. So what you are saying, in fact, is that what we should be concentrating on is better co-ordination and utilisation of data rather than increasing the amount of money we are spending?

(*Professor Hunt*) That has been the song I have mainly been singing at these international bodies.

Chairman: We will make a note of it.

Mr Miller

239. We dealt, in some detail, with the C-130 a moment ago. If I may return to that for some clarification. First of all, am I right in saying that the C-130 is essentially a converted Hercules?

(*Professor Hunt*) Yes. I am wearing the tie. I thought it might come up on the agenda.

240. Like the rest of that fleet it has a limited life. It is part of the replacement of that fleet which is going through the Ministry of Defence about future large aircraft. Now, what life expectancy is there on that?

(*Dr Mason*) The theoretical life expectancy of the aircraft would be as long in the future as 2015. The practical life of the aircraft would probably be until such time as the Ministry of Defence is no longer capable of servicing a C-130.

241. What is your estimated time for that?

(*Dr Mason*) That is a very difficult timescale to estimate. It depends on the exact rate of procurement of the replacement aircraft, but it is expected to be as late as 2010.

242. Now, as the fleet of Hercules declines, the relative cost of maintaining a C-130 is going to rise.

(*Dr Mason*) That is right.

243. Is that built into any of your financial assumptions in terms of the apportionment of cost and so on?

(*Dr Mason*) The current cost of maintaining a C-130 is, as you say, quite high and potentially increasing. We have an undertaking with outside experts to review alternative replacement aircraft which would actually be fit for our purposes in terms of the functions of that aircraft. We believe that it should be possible, if we have a sufficient money stream to maintain a C-130, to have the ability to make an investment and repay it over a period of time, and actually have a money stream to maintain that facility indefinitely.

244. In terms of running the aircraft but not in terms of the capital cost of replacement?

(*Dr Mason*) Including replacement. A replacement of the C-130 would be more likely to be a more modest four-engine turbo-prop, if it was undertaken on a commercial basis. The reason the C-130 was adopted was very much to do with what was practical with the wherewithal of the Ministry of Defence.

Dr Bray

245. Coming back to the observation resource requirements for a moment, in Climate Agenda it says that observations requirements are relatively larger investments since current operations systems are very limited. This was a Climate Agenda estimate in the range of 300 million. Is that additional to the 200 million for the ocean system?

(*Professor Hunt*) In terms of the World Climate Programme activities to date, there has been quite a substantial effort by the United States and France too and some other countries, in terms of the TOGA system and WOCE in the Pacific, which has led greatly to the understanding of the El Nino phenomenon, and it was certainly envisaged that there would need to be some continuing investment in that area. The decision about that has still not been taken. That is the kind of area where significant ocean investment would continue.

246. Would that amount be for a global oceanographic observation system input though?

(*Professor Hunt*) It depends which people talk about it. The bill for the global ocean observation system has varied through two orders of magnitude throughout the last five years. There are people who are saying you have to measure every ten kilometres of the ocean to get every last ocean eddy. Then there are others who have taken a view closer to what is done at the present. To put it another way, the Met Office, working for the Ministry of Defence, will be producing an operational ocean model next year or the year after, which will be run on a basis of daily forecasting and using the data that there is. All the extra data that will arrive will make that better. So we are already in a position where there is a good deal of very satisfactory ocean modelling taking place. The use of the satellites is also an important part of improving that.

247. The difference from the atmosphere modelling is that the technology of the ocean modelling was developed primarily in NERC rather than primarily in the Met Office.

(*Professor Hunt*) I think Dr Mason will talk to you about that.

(*Dr Mason*) And perhaps Dr Carson. The number of physical ocean modellers in the Met Office is actually larger than the number of such ocean modellers in research councils. The number of oceanographic scientists in NERC is, on the other hand, very much larger. Oceanographic science is a very much larger field than ocean modelling. The other point is that ocean modelling has very large amounts in common with atmospheric modelling, so there is a strong synergy within the organisations on the two activities. We are undertaking for the Ministry of Defence the same sort of ocean modelling, and there is good cross-fertilisation in the operational ocean activity at the Hadley Centre. Dr Carson may want to say more about that. It is quite important to recognise that the things which we are using in the Hadley Centre, by and large, are identical to those which we are using for other purposes, so to separate them from us would be a duplication which does not currently exist.

[Dr Bray *Cont*]

(*Dr Carson*) There is no need to add too much more, but just to make clear that the initiative for the development of global ocean models, in order to address the climate change question, that initiative was taken in The Met Office, (as mentioned in our submission), in the 1980s, so by 1986 we already had a coupled atmosphere ocean model. If you wish to address the climate issue using models of that type, these are prerequisites for addressing the climate change issue in the way we do. It was because of that tradition and ability within the Met Office that the only place the DoE could turn to in 1990 for a Climate Prediction Programme was the Met Office. Again, in terms of coupled atmosphere ocean systems, we have one of the recognised best models in the world. What has developed increasingly in the last few years since we became the Hadley Centre is that we are developing a strong interaction, as Dr Mason says, with the NERC oceanographers, particularly at Southampton, (what is now the Southampton Oceanography Centre), in order to help us develop different aspects of our ocean models. They have an interest, I hope, in developing the techniques for ocean modelling *per se*. We are driven by needing the best affordable global ocean model we can have to couple to the atmospheric model to address the questions of climate change.

Mr Miller

248. In amongst all of that an awful lot of data is collected either by you or by the Royal Navy in terms of things like salinity variations and so on that are very important for our submarine fleets. Going back to my first question about the customer, how in terms of your relationship with the MoD is all of that charged? Who picks up the bill for all of that?

(*Professor Hunt*) The Royal Navy is one of the new top-level budget holders who are one of our major customers. The money has been pushed down to them and the Navy can decide whether it wants to have half another submarine or a better ocean model. It makes that decision. In fact, we are working increasingly closely with the Navy because of these capabilities that we are talking about. The hydrographic office is also involved in taking this data and we have connections with them, but, as I am sure you are well aware, operating this model within the secure environment of an MoD establishment means that on the one hand we can work for the Navy and on the other hand the same model can be run for climate models. That would be very difficult if it was outside and one would be in a situation of duplication. I just wanted to reinforce the point made by both my colleagues, that some of the most important work that we do, particularly for stormy tides around the UK, are models that have been developed by the excellent group from the Proudman Oceanographic Laboratory. They are really a world-class oceanographic institution. They are absolutely top class, just as much so as the people at SOC. We work very closely with them and the MoD supports work there. It is an excellent synergy and we see ourselves as this applied operation feeding from the research of NERC.

Chairman

249. I think that would be a good point on which to conclude. We have now come to the end of our session, Professor Hunt. We are very grateful for that and to your colleagues, Dr Mason and Dr Carson. We may threaten you with a little visit perhaps to the Met Office later on.

(*Professor Hunt*) We would be delighted.

Chairman: Thank you very much indeed.

Letter to the Clerk of the Committee from Professor Julian Hunt FRS, Chief Executive, the Meteorological Office (24.12.96)

Thank you for your letter of 19 November seeking the answer to three further questions.

The first question relates to investments in meteorological satellites. This is best answered by expanding my reply to Q237 by giving some further details. Firstly, the satellite programme I referred to is the mandatory European Polar System (EPS) Programme of EUMETSAT, which is being run simultaneously and with the same organisational structure as the optional METOP-1 Programme of the European Space Agency (ESA). The Programme has yet to receive full approval in either Agency, although in both cases the Member States have recently been asked to finally confirm their contributions. The ESA Programme covers the development of the space segment (ie, the satellite and the instruments it will carry), whilst the EUMETSAT Programme will cover development and implementation of the ground facilities for reception and utilisation of the data, and the launch and operations of a series of three satellites lasting from 2002 until 2016. At present it is expected that there will be a shortfall of at least 25 per cent in contributions to the ESA Programme. Within UK it falls initially to MOD to provide the UK share (12.89 per cent) of the EPS Programme and to DTI (BNSC) to subscribe to the METOP-1 Programme. Neither has yet confirmed its contributions.

The principal users and beneficiaries of the EPS Programme will be the meteorological services of the Member States, who are thereby motivated to fund the Programme, and the data will be made available, perhaps at some charge, to other meteorological services and to other communities. EUMETSAT maintains regular contact with its users, especially through an annual conference, and, driven by its users, is developing systems to increase the utility of the data.

The study to which I referred was undertaken on the joint commission of BNSC and the Met Office by Smith System Engineering Limited in 1995. I attach a summary of its findings. The point I was making is that, while EPS/METOP has been developed primarily for operational weather forecasting, and the instruments designed to fulfil the minimum operational need in as cost-effective manner as possible, nevertheless there is considerable potential for the use of the data outside of meteorology. I am confident that promotional efforts will result in many of these opportunities being taken up as the programme develops and as conditions for the use of the data by universities and industry is established.

I hope that conveys the flavour that METOP is for operational meteorology and that it has been designed so that 100 per cent of the data are needed by and used by operational meteorology. Nevertheless there are additional opportunities which I believe should be exploited, especially since some of the instruments will not have been used before.

The second question relates to any changes in the length of contracts with NERC institutes since the Met Office moved to Trading Fund status. Contracts with NERC institutes since 1993–94 comprise a two and four year contract placed in 1995 and a two year contract placed in 1996. It is probably more helpful to include university contracts and the attached table shows the length of all such contracts. Noting the issues of statistical sampling there is no evidence for any trend except that, since 1995, we have sought to place more work with NERC/universities.

The third question concerns PES funding to allow continued use of the C130. I know that MOD is not seeking such increased funding and am not aware of any such plans in other departments. The planned range of users and sources of funding are as described in my document provided to the Committee and the evidence provided by Dr P J Mason.

Extract from Smith System Engineering Limited Report—1995

Summary

The aim of the study was to explore the extent of the non-meteorological and non-climatological uses of METOP-type data by the UK in order to give an indication of the benefits and potential customers of the proposed METOP series of satellites.

A survey performed as part of the study identified a low level of awareness of METOP outside the mainstream meteorological community. Even amongst those aware of its capabilities, few have specific plans at this stage to utilise METOP data directly because of the long lead time to the 2001 launch date.

The equivalent of approximately 200 full-time staff are currently involved in research involving the use of METOP-type data outside meteorology and climatology. In addition, use of such data represents about 10 per cent of the turnover within the UK commercial remote sensing market—equivalent to approximately an additional 40 full-time persons.

Assuming a continuation of current growth rates within the value added Earth Observation market, estimates of the involvement with METOP-type data should be increased to give a total of the equivalent of at least 500 full-time persons by the time that METOP becomes operational.

The actual uptake of data from METOP will depend not only on cost and east of access, but also on what other data streams are actually available concurrently with those from METOP. Operational near real time use of these data is likely to increase as numerical models improve, computing capacity increases and communication bandwidths are extended.

The survey responses clearly identify visible and infra-red imagery [AVHRR] as being of most widespread interest, with demand for data from this instrument likely to increase further in the future. Growing demand for microwave imagery (MIMR) and radar backscatter information (ASCAT) was also identified, with prime applications of these latter instruments including surface ice monitoring and rainfall estimation, and sea surface winds and land surface roughness respectively. These data can be transformed via computation to valuable near real time oceanographic information.

The development of many of the land based applications of METOP data identified during the study is likely to be driven by overseas aid organisations, and in order to ensure maximum utilisation of METOP, it will be important to ensure continued funding of programmes supported by such organisations. Development of ocean-based applications is, by contrast, more likely to be driven by the interests of commercial companies and defence.

In summary, the study has clearly identified very substantial use of METOP-type data in areas outside core meteorology and climatology, and that the variety of such uses is increasing. However, the majority of current users receive data at low cost, are planning on this continuing in the future, and if necessary, are prepared to search the market for alternative low cost data sources.

NERC/UNIVERSITY CONTRACTS 1993 TO DATE

f/y	93–94	94–95	95–96	96–97	97–98
Length (yrs)					
	3.0	1.0	4.0	0.5	3.0
	2.1	2.0	1.8	2.0	
	0.5	3.0	1.0	2.8	
	1.0	3.0	3.0	0.2	
		2.5	4.0	2.8	
			3.0	2.0	
			2.0		
			0.5		
			2.0		
			1.4		
			1.0		
			1.0		
			3.0		
			0.3		
av. length	1.7	2.3	2.0	1.7	3.0

Average length before Trading Fund (yrs): 2.0
Average length after Trading Fund (yrs): 1.9

Letter to the Clerk of the Committee from Professor Julian Hunt FRS, Chief Executive of the Meteorological Office (20.1.97)

Thank you for your letter dated 10 January 1997. You requested advice on how the Met Office would propose to meet its aircraft flight requirements in the absence of a successor.

We do not believe that our requirements differ much from those of NERC scientists. The Met Office aircraft requirements are quite diverse and whilst all of these requirements are largely met with the C–130 no other single aircraft would probably meet all these needs.

In the absence of the C–130 or a similar successor there would be damage to the capability of both the UK and also Europe. It remains our hope that shared use amongst the UK community together with some European Union support will sustain the C–130. If, however, such co-operation failed the Met Office resources would be used to provide some access to aircraft to conduct its research. Of course this would then be on a more limited scale. Some activities, which do not require the usual extensive scientific instrumentation and data processing equipment in the aircraft, would be undertaken on various commercially available aircraft, eg at Cranfield. Other activities would be directed towards international collaboration but some activities would be lost which are particularly dependent upon the wide range of instruments on the C–130 and upon the flight time and range of the aircraft.

I hope this answers your further questions.

WEDNESDAY 20 NOVEMBER 1996

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mr Andrew Miller
Mr Patrick Thompson
Dr Alan Williams

Letter to the Clerk of the Committee from Dr D J Fisk, Chief Scientist, Department of Environment

You wrote on 14 July asking the Department to submit a memorandum to the Committee on its relations with the Natural Environment Research Council. I am pleased to attach that memorandum as approved by Ministers. I have endeavoured to answer your specific questions. However, the precise figures are not necessarily exactly those requested because those for 1996–97 are more representative of the true position following the transfer of some work to the new Environment Agency on 1 April 1996. I understand this transfer included some ongoing contracts placed with NERC institutes.

Memorandum submitted by the Department of the Environment

1. INTRODUCTION

The Committee wrote to the Department on 31 July inviting comments on the relationship between the Department of the Environment (DoE) and the Natural Environment Research Council (NERC). This memorandum briefly recalls DoE's strategic objectives and the objectives of its research programme. It then describes how DoE interacts with the Council and with its programmes, Centres and Surveys. Finally the paper touches on general research co-ordination and in particular on the co-ordination of research into global environmental change which we understand to be a particular interest of the Committee in this Inquiry.

2. DOE'S RESEARCH OBJECTIVES

The aims of the Department's research programme are given annually in the Government's Forward Look (See Annex). The Department procures the research to meet these objective according to the principles laid down for Civil Departments in *Realising Our Potential* (the Science, Engineering and Technology White Paper). Research is commissioned by individual policy Directorates, within a framework overseen by the Departmental Chief Scientist. Of the current (1996–97) £114 million expenditure by DoE and its related Non-Departmental Public Bodies (NDPBs) (but excluding the Health and Safety Executive) some £40 million is spent on research and monitoring in the environmental area.

3. LINKS WITH THE NATURAL ENVIRONMENT RESEARCH COUNCIL

When identifying links between DoE and NERC it is helpful to differentiate between links formed through NERC's role as a research funder and links formed through its role as the operator of a number of nationally important Centres and Surveys. NERC distributes some £165 million from the Office of Science and Technology to carry through its mission. It is assisted in this process by six Science and Technology boards which help to identify the future research strategy. DoE contributes to this process through representation on four of these boards, and on the British Geological Survey Programme Board. The Departmental Chief Scientist sits on the NERC Council. In this way the Council is alerted to developments in DoE policy, and the policies of its relevant NDPBs. DoE also has a formal Research and Development concordat with NERC.

Some of NERC's funds go directly to its Centres and Surveys as part of the overall research strategy, the remainder to a broader research community. Similarly DoE spends about £4 million with the Centres and Surveys and around £25 million with the remainder of NERC's research community.

The European Commission also funds some £5.8 million of NERC research on the usual cost shared basis. This is mostly from the Environment and Climate programme, on which DoE leads for the United Kingdom, and the Marine Sciences and Technology line of the Fourth Framework Programme. Over 1996–97 and 1997–98, DoE will carry over half the attribution for the United Kingdom's contribution to these programmes.

4. Other NDPBs

English Nature and the Environment Agency similarly commission research to support their statutory duties, in accordance with the powers in their respective Acts. The model for procuring research (it is "commissioned" rather than "sponsored") follows as closely as possible that for Civil Departments which is given in the Science, Engineering and Technology White Paper. Since research imperatives follow from specific policy needs, the clearer differentiation of policy responsibilities that results from day to day working between these bodies and the Department does much to alleviate the need for intensive co-ordination between the relevant NDPBs and DoE. As a broad rule English Nature and the Agency programmes tend to be site or problem specific. DoE research tends to be more strategic as appropriate for the basis of environmental legislation. Both the Environment Agency and English Nature have concordats with NERC and they are entirely responsible for specifying and letting their own contracts.

5. Assessment of Current System

Overall we believe that the present system in the United Kingdom, which was described in the Science, Engineering and Technology White Paper, offers a number of advantages. The research Councils provide the seed corn funding that enables new skills, training and the exploration of first ideas. The Research Council responsive mode enables these ideas to be fleshed out. Thematic programmes enable economies of scale and concerted effort in areas of strategic importance, exploiting the advantages of national facilities and institutions. Finally end users like DoE and industry can pick up strategic research and commission research directed at specific applied needs, closely designed to meet value for money trade-offs. Often this is a two way process with outcomes from applied programmes opening up new issues in basic and strategic environmental science.

Although the Government Forward Look provides an opportunity to view research plans some way ahead, expenditure in any one year will need to take into account unforeseen calls on resources and the economic situation at the time. It is recognised that this can cause difficulties in the development of long term programmes co-ordinated between Departments and Research Councils.

6. Developments in DoE-NERC Links

The concordat between DoE and NERC has produced a useful platform on which to develop new links. For example we have taken the opportunity of the sector dialogues initiated in the Competitiveness White Paper to introduce NERC to potential customers for the work which it funds. This initiative complements NERC's other activities in this area. Existing links between DoE and NERC on strategies for the European Framework Programmes of Research will deepen over the next few years. DoE leads in Whitehall on the negotiation of the environmental elements of the Fifth Framework Programme. The United Kingdom hopes to improve the focus of this Programme towards European environmental policy priorities, specifically in support of the Fifth Programme of Policy and Action on the Environment and Sustainable Development. It will be necessary to work closely with NERC to ensure that the development of the Programme is taken into account in planning the United Kingdom's research strategies.

7. Inter-Departmental Research Co-ordination

Research co-ordination requires striking a balance between overall control and excessive bureaucracy. Following the promulgation of the delegative model of research procurement in the SET White Paper, DoE has been working with the Ministry of Agriculture, Fisheries and Food, Department of Transport and the Health and Safety Executive to devise a light-touch system of co-ordination. We now have a matrix of focal points of interests between Departments, as well as exchange of research programme information. We intend to extend the system to other bodies such as the Department of Health. This system appears to be working well and complements a number of over-arching co-ordinating mechanisms such as the Inter-Agency Committee on Marine Science and Technology and Inter Agency Committee on Global Environmental Change.

8. External Advice

Within the DoE, research needs are assessed in the individual policy divisions. New research requirements for the forthcoming year are detailed in Research Newsletters which are issued each spring. Outside advice is frequently used for this purpose. The independent review groups which assess for the DoE the state of knowledge in specific areas from time to time often identify outstanding issues which could be resolved by research. The Royal Commission on Environmental Pollution often makes research recommendations as part of its findings in a particular area of environmental policy. Since European or international environmental negotiations play a very important part in the development of environment policy, the timing and scope of research projects is often set by wider agendas.

9. GLOBAL ENVIRONMENTAL CHANGE

The Committee has expressed particular interest in the issue of research into global environmental change. Research related to global environmental change takes place through a number of international frameworks such as the International Geosphere Biosphere Programme and the World Climate Programme. Since 1989 UK research on global environmental change has been co-ordinated by the Inter-Agency Committee on Global Environmental Change. Heads of relevant funding Agencies attend the Committee which is currently chaired by Sir Ron Oxborough, Rector of Imperial College.

The Committee has prepared, and recently published, a Global Environmental Change Research Strategy. It has also provided a useful forum to develop UK positions for a number of international meetings, for example a policy on access to environmental data sets. It maintains a database on our national research, development and monitoring activities.

The current structure of the Committee reflects the balance of interests before the Science, Engineering and Technology White Paper and before the future international environmental agenda was set by the Rio Conference on Environment and Development. For example since the Committee was formed the responsibility for research into Earth Observation has been transferred from the former Science and Engineering Research Council to NERC. DoE currently represents the interests of other policy Departments through its lead on human induced climate change. However the global environmental change agenda is notably wider than just the issues raised by the Climate Change Convention. DoE believes that the Inter-Agency Committee plays a useful role as a senior level committee and should continue, but possibly with some readjustment of membership to reflect the new balance of interests.

10. CLIMATE CHANGE

The DOE leads on policy on human-induced climate change. It funds development of climate prediction techniques at the Meteorological Office's Hadley Centre as part of the UK's contribution to the international effort on climate change research. There are strong links between the Hadley prediction programme and the NERC climate science community whose results are incorporated into prediction modelling. In some crucial areas the DoE commission the NERC community directly to speed the use of research results in improved models. The Hadley climate prediction model is widely recognised as one of the World's leading models in this very challenging area. DoE also funds a data link by the University of East Anglia which provides access for climate impact researchers funded by NERC and others to the latest Hadley model runs. The Meteorological Office has its own close links with NERC. The Meteorological Office's Chief Executive sits on Council and there is constant exchange of science between the Meteorological Office and the NERC community. However this work is of a global nature. The Hadley model draws on international science. Similarly the Council's Universities Global Atmospheric Modelling Programme has made valuable contributions to other international work such as the European Medium Range Weather Forecasting Facility.

11. FUTURE ISSUES

The Government published its Sustainable Development Strategy in 1994. This has subsequently been reviewed in its annual White Paper *This Common Inheritance.* It recently also published for comment a number of sustainable development indicators. In many areas the physical environment shows encouraging signs of improvement, and the general trends in emissions over the next decade is downwards. However, the analysis also shows a number of emerging issues which need to be tackled, often in an international context. This includes the threat of human-induced climate change and the possibility of devising mitigation and adaption measures.

Research has contributed greatly to the improvement in climate prediction models. Our confidence in the atmospheric component of these models continues to increase but other aspects of current models are more difficult to verify. This is particularly true of the oceans where there are formidable computational difficulties and limited data. This represents a substantial challenge to the global scientific endeavour.

There are of course other major issues in global environmental change to which British science makes a significant contribution. These include the assessment of the loss and implications of global biodiversity, and the condition of the oceans and world fisheries. The latter is an area which the United Kingdom has made a special effort to advance before the United Nations General Assembly Special Session reviews next year progress since Rio.

Annex

DoE RESEARCH

DoE Aims

The aims of the Department of the Environment, given in the Forward Look, are to promote good government, sustainable development, the quality of the natural and built environments, and economic competitiveness. To this end it encourages and funds science, engineering and technology in support of Departmental policy, statutory, operational, regulatory and industrial sponsorship responsibilities. Wherever possible it involves and co-operates with others in meeting these responsibilities and ensures that the public has access to the results of the Department's research.

DoE Organisation

The Department's main policy responsibilities cover Environment Protection, Local Development, Housing, Planning and Countryside. In 1995 responsibilities for Health and Safety were transferred to the Secretary of State for the Environment. In view of the limited interactions between the Health and Safety Executive research programme and the Council, Health and Safety Executive research is excluded from the scope of this memorandum for clarity. In addition the Department sponsors a further 35 Non-Departmental Public Bodies. These include English Nature, the Joint Nature Conservation Council sponsored via English Nature, and the Environment Agency which was formed in April of this year.

DoE Research Contracts

These research objectives are met through contracted research. The Department spent £88.1 million on research and development in 1995–96. Its NDPBs (excluding the Health and Safety Executive) spent a further £8.3 million. In addition £17.9 million was spent on technology transfer in the construction, energy efficiency and environmental technology sectors through programmes co-funded with industry. In accordance with the principles of the Science and Engineering and Technology White Paper (para 5.7) research is commissioned through multiple tender as far as possible by the relevant policy division. At any one time the Department has over 1,000 contracts in play involving some 300 or so contractors.

At the beginning of each financial year DoE publishes research newsletters for each of its areas of work indicating new work which is likely to be tendered in the forthcoming year. The criterion for selection is best value for money. This may be obtained through commissioning work from overseas research institutions (the procurement directive in any case requires contracts over £158k to be tendered through the Official Journal). However it is a reflection of the very high quality of British research that the vast majority of the work is commissioned in the United Kingdom. NERC's Centres and Surveys account for four per cent of the total DoE programme of £114 million. In a minority of cases funding is jointly with NERC. Experience suggests that it is better where possible to co-ordinate the interfaces of programmes, rather than joint fund, in order to ensure effective programme management.

The main body of DoE expenditure with NERC consists of some 45 current research and development contracts ranging from six months to over five years in duration with an average duration of just under three years. NERC also holds some subcontracts grants and consultancies of shorter duration. However, projects form part of programmes which may have a considerably longer horizon. For example the DoE programme on acidification, which is now coming to maturity, began in the mid 1980's.

Examination of Witness

Dr David Fisk, Chief Scientist, Department of the Environment, examined.

Chairman

250. Dr Fisk, you will know that the Committee is undertaking an inquiry into NERC but pretty early on we decided that the biggest issue currently on which we are engaged is the question of global warming and climate change and all the related issues, and you were kind enough to come here and accept our invitation in your capacity as Chief Scientist in the Department of the Environment. May I say we are delighted to meet you. I think this is the first time?

(*Dr Fisk*) This will be the first time.

251. We have already had the benefit of evidence from Sir John Houghton, as you may know, and he gave us a lot of information about this and, among other things, he was concerned that there was no one body to take the lead in considering the "Climate Agenda and the whole of international climate science." Do you agree with that?

(*Dr Fisk*) I agree that there is not one body, Chairman. I am a little doubtful whether there is a very pressing case for one. There may even be a case

[**Chairman** *Cont*]

that one single large body would, if anything, slow some of the process. Perhaps it would be best if I just explained where the Department of the Environment sat in that firmament since I appear to have taken a slightly different view from the distinguished Sir John.

252. That would be very helpful.

(*Dr Fisk*) The Department of the Environment has the policy lead in Whitehall for the response to manmade climate change. We lead the United Kingdom delegation to the Framework Convention on Climate Change and, as it happens, the policy divisions concerned are within my directorate. As a government department, we therefore commission the type of research that we need in order to support that function. Therefore, the very first thing we have funded is very strong support for the Intergovernmental Panel on Climate Change, which has been introduced to the Committee on several occasions. The rationale for that funding is very clear. The United Kingdom has a long tradition of gaining as much evidence as one can about the science before taking precipitate decisions and it would certainly have facilitated our points in the international arena if we had managed to ensure that the best science had been accumulated before decisions were taken. So we have been very keen in the Department of the Environment to support the IPCC and we put in some very substantial funds for supporting the IPCC processes and the science assessment, on which Sir John leads. I might say, Chairman, that the IPCC is quite a novel international institution. To my knowledge the United Nations system has never tried anything quite as ambitious before. Its texts are offered for peer review to a larger number of scientists than we have ever tried in any other arena; it endeavours to write a consensus text rather a particular vision. It really does represent, I think, the most major undertaking in this area. Not wishing to dispute your opening remarks, Chairman, there is a concern in the Department that other areas of global environmental change, such as biodiversity, such as the state of the ocean stocks, actually do not have the benefit of an IPCC process at the beginning of deliberations on research. The Biodiversity Convention has just completed its third conference of parties and actually at no time knew whether global biodiversity had got better or worse during the preceding year. So we fund the IPCC process, Chairman, but we also fund the Hadley Centre model and its development because we see that as an important contribution to international consensus. The Hadley Centre model is the leading model in the world, because we need to convince other countries of the actions they need to take. There is not much rationale for every country having its own climate model. We are not funding it simply to know what the Met. Office would think; we are funding it because it is amongst the top five, maybe it is the top at the moment, climate change models in the world. But what I would say, Chairman, is that our funding of the Hadley model would work along the following lines. If we were told by Hadley that the best ocean model that was available was available from Princeton University, then I think we would probably fund them to connect to that model. If we were told that the best model of clouds was to be found in the Moscow Hydrometeorlogical Institute, we would fund them to obtain that material. It is not a part of a United Kingdom system for applying strategic research and, indeed, the NERC programme has often made a very important contribution to the structure of other people's models, including that at the European Medium-Range Weather Forecasting Centre.

253. Could I stop you at that point because you are broadening, quite understandably, your answer. You started off by saying that you are not certain that there should be a need for a single, as it were, co-ordinator and leader of the whole range of issues in connection with international climate change, no need for one body to lead. You now go on to say that as the DoE you would wish to influence, indeed in some cases, let us say in relation to the Hadley Centre and so on or somewhere else, you would take a view about that. There is, therefore, a dichotomy. The DoE is the government department most obviously associated with the range of issues concerning the international environment of which we speak, so you presumably have policies about that which you either prosecute or do not prosecute. Am I right on that?

(*Dr Fisk*) Because we negotiate the Framework Convention on Climate Change, the commitments that the United Kingdom undertakes under that Convention are negotiated by my Department and my Department takes the lead on delivering the United Kingdom's own obligations under that Convention, if I understand the thrust of your question correctly, Chairman.

Chairman: Yes, that is right. We had Drs Mason and Carson and we had John Hunt last week to discuss these issues and we recognise that point. What we were trying to establish at the outset of our discussions this afternoon is the role of DoE and you have given us some insight into that. Spencer?

Mr Batiste

254. If I could clarify my mind a little bit more before we move on, essentially you have this policy-making function and you need to be informed by scientific information in the best way possible and in a sense you are quite happy to finance or subcontract it to wherever the best source of that scientific information is?

(*Dr Fisk*) Yes.

255. Your Department is basically concerned with the advice it receives for the money it gives so that it can inform its policy-making process?

(*Dr Fisk*) In fact, Chairman, if I could offer the gloss, it is so that the international community can inform its decision-making, because this is an area in which nobody cares about the United Kingdom's CO_2 emissions as they are relatively so insignificant. It is about the collective view in an international forum.

Chairman

256. So really IPCC and all that flows therefrom is the real source of power in the matter?

(*Dr Fisk*) Absolutely.

Dr Bray

257. The IPCC process has played an important part but it is basically a review process, as you have said. There is also the research planning and research management function and there the most concrete, comprehensive form it seems to take is in the document, *The Climate Agenda*, which is a product of the World Meteorological Association, UN agencies and ICSU. That is really a rather different way of proceeding, basically through the peer group self organisation as opposed to a strictly governmental programme by a government agency formulating and pursuing a research programme or a UN agency formulating and pursuing. If one characterises this as a peer group versus UNICE programme, would you agree that we are at present heavily committed to the peer group programme?

(*Dr Fisk*) I think that the IPCC represents a part of the total, shall we say, climate agenda. It is about measurements and determination of anthropological interventions into the climate system, but the world climate research programme has always had a broader research agenda than simply that issue. It has been the basis of international climate research which has enabled some of these recent, quite remarkable, year-over-year forecasts. We have had tremendous economic benefits in some parts of the world in terms of projecting micro climate of some international crops. Some of the medium-term inter-seasonal forecasting being explored has drawn on research which is not even touched by the IPCC process. IPCC is concerned principally with the effect of man-made emissions on the climate. It touches on natural variability but clearly that variability is an important part of our understanding of not just man-made interventions but of living successfully on this planet. The Climate Agenda ICSU programmes have looked at broader climate issues as well as just the issues referred to in the IPCC.

258. In scientific terms if we take statistical trends it is not possible to distinguish between naturally occurring and man-made interventions because they are talking about the same phenomena. It is different aspects of the time series perhaps but that is a very difficult thing to tracking down where you would not really stand a chance of looking at man-made interventions without having a very good characterisation of the naturally occurring change.

(*Dr Fisk*) I think, Chairman, Dr Bray touched on the key difference which is time-scale. The IPCC has invited itself to look at timescales which in most other agendas would be remarkable, 2100 and beyond. The type of information and science and the issues that is raising are different from our ability to compute inter-year the effects of the El Nino effect, for example. Very much drawing on the same basic science, I would not want to dispute that Chairman. But one is often concerned that the broader issues of climate change science are not forgotten whilst one is concentrating on the area which is certainly my Department's interest, the anthropological effects.

259. But what is difficult about the validation of that particular situation of climate change over the past, and paleo-climate problems where timescales are very much greater than just a single century and an important part of the scientific argument, is that the study of the naturally occurring changes does provide a very much better feel for the background of man-made interventions than you could possibly get just by modelling those on their own.

(*Dr Fisk*) I am not, Chairman, disputing the role of paleo-climate studies either. I was simply making the distinction that there is quite a substantial benefit to be had from looking at what we can do with modern technology in looking at short-term changes in the climate. One should never forget that that is quite valuable.

260. That demonstrates the complexity and interaction of science in these areas, nevertheless it does contain a coherence, for example we have a thing called average global temperature. When you come to talk about biodiversity which, as you said, is a very important aspect of global environmental change there are no such simple single variable characterisations of change. Are we not merely in an altogether different scientific ball-park when it comes to designing research programmes on subjects as complex as biodiversity?

(*Dr Fisk*) Chairman, I would certainly agree we are in a very different ballpark. My concern is that this complexity makes it more pressing to have an ability to assess the science, because it is so much more difficult to grasp. In the climate change area it has been an easier task than biodiversity. In biodiversity, is a great challenge and it is very hard to pull together some of the threads.

261. Would you be in favour of an inter-governmental panel on biodiversity?

(*Dr Fisk*) The United Kingdom I hope gained a small success in the recent Conference of Parties that has just been completed. We have managed to persuade the Conference of Parties to begin a quantitative programme of monitoring biodiversity—that is, what do the national biodiversity programmes lead to—and I think that is an important step. There certainly have been suggestions that there might have been something like an inter-governmental panel to address the issues of the ocean. The government's sustainable development panel made such a suggestion. All that suggests to me that people find the IPCC a very helpful model, even if they have not quite found the impetus yet to bring it into these other very important areas.

Mr Thompson

262. I am afraid my mind is still fixed on the original issue we started out with which is the question of the lead body in considering the climate agenda. I must admit that I suddenly realised my training in physics did not qualify me to follow all that has just transpired! Going back to the beginning on the question of a lead body for climate change research would it be possible to pass on this lead to NERC or any or all of this research? A straight forward question on which I am sure you have an opinion.

(*Dr Fisk*) Since the rearrangement of research council responsibilities with the publication of the "Realising Our Potential" White Paper, the NERC is already the largest single funder of strategic research in this area. The transfer of the responsibility for

[**Mr Thompson** *Cont*]

earth observation studies was actually quite a bold step at the time. It is one of the few councils of its type in the world that not only has responsibility for normal terrestrial techniques but for once has been given the opportunity to get into earth observation.

263. NERC is not taking the lead on that?

(*Dr Fisk*) May I help you, Chairman. In terms of the funding of strategic research, NERC's mission, as I would understand it as a member of the Council, is as the leader because it funds the majority of the strategic science. As I explained, it is rather like the parallel of any other policy area and, as explained in the White Paper, DoE certainly funds areas that relate to the immediate informational policy needs of the United Kingdom in negotiations. I was hinting earlier there are much wider issues about climate and climatology that would certainly not fall on the Department of Environment.

Chairman

264. Can I ask for clarification is this then a proposition that says that if there is a more urgent need for the Department or for Ministers to have advice on specific issues that may be raised on the matter then the DoE will try and provide answers to that but if it is a matter of long term and IPCC-generated commitment to the climate change agenda then it is better that be done through the existing system?

(*Dr Fisk*) Chairman, the model I am offering you is probably the one in our memorandum and does not differ from the various funding bodies that relate to acid rain issues, for example. My Department funds a number of international exercises including some modelling of acid rain. The models are in response to a fairly detailed policy response agenda but the NERC has also had a strategic programme about the changes in the eco-system of increased acidification. This has been going on for quite some while, and below that, under the dual funding system, there will indeed be a number of quite innovative small-scale programmes funded outside the NERC system.

Mr Thompson

265. What is or should be the role of the Office of Science and Technology in all this? I say this quite genuinely, I am now getting somewhat confused about where we are as regards who is taking the lead, who is responsible. It may be my lack of knowledge on the subject but I must admit I am more confused now than I was at the outset.

(*Dr Fisk*) That is never an encouraging response for a witness.

266. I may be criticising myself but I am telling the truth. I am confused. What is the role of the Office of Science and Technology?

(*Dr Fisk*) Can I have a shot at clarification of the point I made and then a remark about the OST. The proposition I was putting to the Committee was climate change is rather a large catch-all subject. There are different issues tucked within it, including what position should the United Kingdom take in the Framework Convention, what sort of new models do we need for inter-annual inter-seasonal prediction and what sort of strategic science will be most useful ten years from now? Each one of those topics is relatively distinct and pretty clearly in the stable of one of the players within this group. So that if you look at the Inter-Agency Committee (which I am sure we will get on to in a moment) each one of the members of that Committee has a clear role, that it is playing that justifies the research it funds. The Committee is actually a good way, in my view, of bringing together what co-ordination or common action is necessary. On that sort of model, Mr Thompson, the role of the Office of Science and Technology would largely come from its ability to fund and listen to the bids and proposals from various research councils. It may have to adjudicate between those in the bidding processes, which clearly are not part of my Department's business, but also to make sure that a Committee like the IACGEC is operating properly and actually other players, like my own, are fully connected into its process. What I think I would say to you is that the United Kingdom process on climate change is actually one of the best in the world at the moment. In my view, this is partly because there are a number of advantageous pressures, as we said, such as the political agenda, which have enabled it to keep it very tight and well focussed. My remaining concern still is in other areas of global environmental change which no doubt will be part of a future Committee study.

Mr Batiste

267. In other words, going back to where we were before you started this, you perceive your purpose here is to fund and initiate the research that is designed to inform your policy-making process?

(*Dr Fisk*) That is right, yes.

268. Issues about coherence of science, strategic research issues, are nothing to do with your Department. These are to do with OST. You have a policy need that needs to be informed. If the information you need is not there, then you stimulate it?

(*Dr Fisk*) And just as we would expect OST to consult us on their views about coherence and so on, similarly we would make every effort, if we were making changes in our programme or direction, to consult colleagues in the other areas. The reason why I would press this as a model, Chairman, is that I think science that is championed by people who are going to use it is always much more effective.

Dr Bray

269. You have referred to the Inter-Agency Committee, which has a very august membership of very busy people who are two of them expert in the field they are looking at, although there are one or two who are not. Is that really the appropriate body to have in charge of the distribution and requirements of research that is done?

(*Dr Fisk*) Mr Chairman, that is quite a challenging question. The Department of the Environment took a very active interest in the original thinking behind the formation of the Committee. I confess that we drew partly upon our rather depressing experience in taking part in very much larger research committees,

[Dr Bray *Cont*]

many of whom were able to draw up extremely large menus of research needs but did not actually have two pennies between them to fund any of the needs that they had identified. This often produced a tremendous amount of work and paper but was not very satisfactory in executive action. So we were one of those who pressed for saying that the real need here was to have a committee, let us say at CEO level, as it would have then been in the research councils, which was actually able at the end of the day, after we had had the debate to conclude a decision on which actually it could take some action. The data policy that IACGEC devised was something that was able to be endorsed by those present, who actually got on to taking some action. In arguing this, we followed up very much the model as we understood it, of how the American system worked. That is its top-level inter-agency committee was essentially quasi-executive. It was able to say, "I agree to this particular proposition. I am able to deliver my agency to meet whatever it may be called on to do." The Inter-Agency Committee has always recognised that it is not a technical or expert committee and it has always worked through appropriate expert subgroups in different areas. I can see over my shoulder that you have the distinguished Professor Hoskins, who will describe no doubt the work his group did in helping the IACGEC draw up its report. But DoE was very concerned that international collaborative science does have a terrible committee disease, which has not always helped it make very firm and clear decisions, and there was a lot to be said, particularly in the early days before the re-arrangement of research council responsibilities, for getting the heads of research councils at the same table and giving commitments to those things that they had decided. I think in that respect the Committee has worked rather well and rather efficiently, but it is a very senior level committee, as Dr Bray has said, and it actually does most of its material work through other layers of operation.

270. You have said you characterise the United Kingdom system as efficient by international comparisons. Nevertheless, that does not mean it is very tidy. Are there possibilities that perhaps over-tidy minds will ask questions like, should not the Department of the Environment be responsible for the Met. Office, or should the OST be doing the Met. Office? Is it not a bit anomalous that this continues to be the responsibility of the Ministry of Defence when no other Met. Office in the world is under the Ministry of Defence?

(*Dr Fisk*) That is a challenging question but the Committee will be aware that very recently the conditions for the operating of the Met. Office have changed somewhat. It is now a trading fund with a large shared core programme amongst a number of Government customers. So in some sense MoD are the stewards of the programme. This would be a better way you might describe it, rather than actually being managers or directors of it. There is a stronger involvement of a core set of customers. As it happens, DoE, not wearing its climate change hat but wearing the hat of its weather prediction requirements, is one of the core members of that customer group.

271. Supposing the going gets rougher and we have to face government decisions arising in the manmade global climate change field which match the urgency of the BSE problem. Would the management of the research in those kinds of circumstances, where you have to deliver firm advice on difficult scientific issues in support of current policy, be adequately discharged by present arrangements or would it require a tighter link with the Met. Office?

(*Dr Fisk*) My own belief is that this type of framework in the past has actually worked rather well in those circumstances. It is a little difficult to invent a scenario that one is going to put on the record, as it were. But let us suppose that there were to arise a tremendous concern about the migration to the UK of some awful disease from the Mediterranean area because of apparent continued warming of our summers. Under the inter-agency model it would actually be the relevant lead department that had to do something about it, in that case Health. The Department would have assembled MRC support or its own funding very rapidly for that issue. One of the advantages of having those who have to take the action fund the relevant research is that they often, therefore, give the highest priority to making that funding available. It would be much more difficult, I think, for the Director General of the Research Councils, who would be quite rightly first home to balance other priorities, whether it is for PPARC and others, all at the same time. So I think that is where the present system works very well.

272. Can I volunteer an example. The effect of the oil fires in the Gulf on climate change, either regionally or globally, was examined quite quickly, do you agree?

(*Dr Fisk*) Yes, they were indeed. Yes, that is correct, and in that particular case, if that helps the Committee, there were modellers at the Met. Office, who as I recall would otherwise have been concerned with the forecasting of air pollution movement in the United Kingdom under a quite separate part of DoE's contracts with them. They set aside some time on their modelling exercises to look at the type of behaviour of Kuwaiti oil plumes. Indeed were able to brief Mr Heseltine, my then Secretary of State, before he went out to look at the state of the Kuwaiti oilfields as to what the conditions might be.

Mr Miller

273. Dr Fisk, I am sorry I missed the first part of your contribution; I was elsewhere in the House. It is always a difficult matter putting money into scientific endeavour but given your response to Dr Bray's earlier question, how exactly is financial responsibility for aspects of environmental research divided between DoE, NERC, the Met. Office and other interested parties? Other interested parties might be other parts of MoD's interest, I guess. Does each have a clear area of responsibility?

(*Dr Fisk*) Yes. This gives me an opportunity, Chairman, maybe to clarify by reinforcement the point I was making earlier. As the IACGEC operates, each party's position at the table follows from the mission statement or policy responsibility of their research funding arm. DoE has a clear responsibility that follows from being the guardians

[**Mr Miller** *Cont*]

of the Framework Convention on Climate Change and the commitments we enter into there. I did actually explain earlier a little about how our rationale for funding both the Met. Office and the IPCC would follow from that. The NERC and the other research councils are there because of their mission statements (with which the Committee will be very familiar), for which global environmental research will be part of the package. The Met Office also has interest in climate prediction other than global climate change by man. If I were to suggest one modification in the Inter-Agency Committee, since it is up for review, it is that its present configuration represents the key executive players at the time it was formed. Now that the agenda has moved on somewhat it is probably less important that one or two of the research councils are present. The NERC, as I said earlier, is a much larger single funder of the GEC programme and therefore it is right for it to take a larger part. At the moment the DoE represents the interests of all other government departments which have an interest in climatic change. Perhaps that will be a little less workable when we move over to worrying about research underpinning some adaptation policies. Departments like the ODA and maybe MAFF also have a legitimate role at the table in order to make their contribution.

274. If I could push a little further. Amongst your scientific expertise you have some people who are quite brilliant at producing models and I want to push you on the modelling side a little further. Let us look at some financial modelling. If a department had a particular high priority but funds were not built into the budgets, how would it be assessed? It could be something as obscure as the MoD were worried about radio transmission to submarines because of changing salinity or something as obscure as that. That could be a high priority area hypothetically. How would that be dealt with?

(*Dr Fisk*) We fund the development of the climate change model principally for large climate simulations that are key to the debate in the Intergovernmental Panel on Climate Change. If a particular government was particularly motivated by a concern, suppose the Overseas Development Agency was concerned about future food security because of climate change, since it is a public model for which they could contract some further running time from the Hadley Centre to look at their particular aspect of the problem. If they felt that the model was not significantly detailed in its configuration for their particular concern there is no problem in investing a little more in the model in that particular direction. They would naturally consult us so we knew what was going on, but they would not have to pass the money to us in any way; the model is a national facility. One of the projects the DoE has funded is a programme called Link, rather unhelpfully for this Committee which is familiar with LINK in a different context. It is an operation by the University of East Anglia which makes available to experts in impact analysis the outcomes of the latest run from the Hadley models. This enables this work to be diffused to impact analysers who may be the sort of people that a department like the MoD or the ODA would actually want to go to in the first instance. It may not be that the future weather maps are of great interest, but their implications for certain types of impact. We have gone as far as to say these models should be widely diffused so that they can be used—

Chairman

275. Are we right to conclude from that, Dr Fisk, that accessability to the models is pretty broad and with DoE agreement a lot of individual priority issues can be, as it were, accommodated within the system?

(*Dr Fisk*) Subject to me offering you a later correction, Chairman, it is my impression that the slightly earlier generation of the model is being run in something like ten other countries because these countries also have particular concerns about climate predictions. So the models are very open to the public in that respect.

Dr Williams

276. Does anyone monitor across the government departments how much is spent on research into climate change?

(*Dr Fisk*) The Inter-Agency Committee on Global Environmental Change has attempted to draw up this figure from time to time and a number of the Committee's reports have given rough estimates as to what that figure is. My own belief is—and the Hoskins Report looks at how that number is parallelled in other countries—that the figure is not actually all that informative. One of the most optimistic estimates we have had of expenditure on climate change was when we were invited one time to include the whole of the nuclear power programme because clearly this was abating greenhouse gases and therefore was part of the government's legitimate response. There is inevitably in an all-embracing issue like climate an amount of double counting with other programmes. For example, much of the work that goes on in BBSRC about crops will have taken into account issues about climate. It was principally funded to look at new crops and new crop technology. The problem occurs in adaptation. We can get figures for some sort of focus areas like how much is spent on climate modelling, on meteorology, or on oceanography, but even where you have got an area like oceanography research it is becoming a little bit diffuse at the edges. Once you get to adaptation measures you are drawing on a much wider group of sciences and the figures become a little flaky at the edges. My impression is that internationally these figures are usually issued with a health warning not because people are misleading but because the definition is so problematic.

277. Is there an individual committee or department which has responsibility for an annual review of expenditure specifically in this area?

(*Dr Fisk*) In my view that would be an appropriate task for the Inter-Agency Committee which it has discharged on previous occasions. Actually one of the things that Professor Hoskins was invited to contribute in his study was an estimate of expenditure.

[**Dr Williams** *Cont*]

278. Are there problems of overlap when there are eight, ten or twelve government departments or agencies involved in research in this area?

(*Dr Fisk*) Partly because we are very clear on being mission driven in this process I am not aware of any substantial overlap that has emerged. There is a lot of effort put in closer to the working level to ensure thorough co-ordination and working with other groups that we are not getting ourselves top dispersed across the agenda. The European Community's Research Programme, which we have not mentioned yet Chairman, is of course another opportunity to obtain knowledge of what is happening in the other networks.

279. Can I come back with a very brief question. I detected a fallacy in one of your replies to Dr Bray earlier where you felt that this inter-departmental funding was very healthy and a responsive method of funding and quoted this Mediterranean bug and if it was a threat to health the Department of Health will cover it. Does that conflict with the "polluter pays" principle because it is the DTI and industry generating the problem so should it not be them in a sense rather than the Department of Health which is the one that is actually suffering the problem?

(*Dr Fisk*) Chairman, no witness from the Department of Environment would ever deny the polluter pays principle! If you remember, my example was predicated by what the policy action was and who would lead on it. If we had, in my awful scenario which I hope never takes place, all the abatement DTI could provoke from the UK, it would not change the global climate. What would have been the major intervention would have been a health intervention. There would be a need to decide whether health intervention was likely to be necessary and what areas of the country might be affected, and all those types of issues which the Department of Health would have led on. I was not moving away from my model but perhaps I had not explained the detailed scenario I had in mind.

Chairman

280. Could we turn now to the Climate Agenda. This seems to suggest that observing systems need significant improvement. Last week, as I think I mentioned, we had Professor Hunt here and he told us that better use of existing data was as important as, or even more important than, new systems. What is your view on that?

(*Dr Fisk*) The Department of the Environment is largely informed by its scientific advisers, that is, the Met. Office and colleagues in the research community, on this issue, so I can only really describe how it looks to us at the moment. We have for some while been told by Sir John Houghton that there is in the long-distant future, maybe also the medium-term future, substantial investment in global observation systems which will need to be put in place. He has chaired a number of very interesting meetings which have looked at what that technology is and tried to estimate its total scale. In our own view at the moment, that work has not come to the point of an easily assessable case for when those systems will be appropriate to come into play. I think Professor Hunt is correct in saying that we do receive signals, not only from United Kingdom research workers, but from people in a number of other countries, that there is a very worrying concern about the state of the current data networks. Despite the international concern about climate change, in many countries there are fewer observing points now than they have been before. Sometimes the data is not easily available; a number of countries restrict the availability of data for apparent defence reasons, for example. Professor Hunt must be right to say that the international community has not fully grasped the need to have its present data sets widely available and widely used. But there are some long-term difficult problems on quite large scales of funding which the international community has yet to complete its deliberations, which I think Sir John is quite right to signal are coming our way.

281. If you agree that there are likely to be some big issues, what would you consider as high priority improvements, and obviously that would involve you taking a view about the international commitment as well as in the United Kingdom itself?

(*Dr Fisk*) Are you talking about observation systems, Chairman, or climate change modelling?

282. Yes, observation systems.

(*Dr Fisk*) The work we fund at the Met. Office I would believe still has a number of areas of basic physics which are in some need of attention. Certainly that is what the Met. Office will tell us. One of the major changes in recent times has been our incorporation of aerosols, the cooling effect of aerosols, in the models. Everybody agrees that aerosols are probably the most difficult part of the atmosphere to model effectively. The present Met. Office scheme appears to be very successful, at least at the global average level, but there are some tremendous difficulties in getting that science right when one is looking at a much more regional level. Many of the models, for example, give quite different answers to the future of the Indian Monsoons depending almost entirely on how the aerosols are modelled. So I think within the group of immediate concerns there are some issues about data and observation which will improve the nature of the models themselves. But as computing power gets better invariably you are moving towards a position in which the models of the oceans would be more ambitious in the amount of data they use. There is not a great deal of point collecting vast quantities of data about, for example, the condition of the oceans, if the computing power of your models is unable to absorb it. We are moving to periods of parallel computing. We do not use it at the moment in the Hadley Centre model but it is clearly a technical element on the agenda, and that is going to open up the opportunity for very much better ocean modelling. So I think I would put that as very much on Sir John's agenda. Perhaps Sir John was observing that very often these international collaborative efforts do take a great deal of time to get going and perhaps he is right to signal earlier rather than later that these issues are in the pipeline.

Mr Batiste

283. Do you find at the moment in the research facilities and institutes which are available for you any difficulty in initiating the research which you need for your purposes here in the United Kingdom and resourcing it?

(*Dr Fisk*) I am not aware, as Chief Scientist, of any difficulty that could be called substantial. The United Kingdom has a tremendous reputation in this area, as I can tesify as someone who was a negotiator in the Framework Convention on Climate Change. The quality of British science, its commitment to integrity and being remote from political influence has been first-class, probably unmatched in the other agendas. Clearly some other countries may get their act together in due course and make substantial funds available, but at the moment I would have thought the United Kingdom really did have an intellectual and structural lead in this area.

Chairman: Could we turn now to the relationship with NERC. Dr Bray?

Dr Bray

284. You place considerable research confidence in the number of research contracts you enter who would like to have continuity of funding. Are you able to give them that assurance and is the average duration of such contracts rising or falling?

(*Dr Fisk*) Chairman, I am conscious that while I was trying to do one of my taxonomic descriptions earlier I caused the Committee some confusion, but I think certainly within DoE we make a fairly strong distinction between NERC as a research community, which includes everyone who is likely to be funded by NERC, and the NERC centres and surveys, which are an important part of it, but we would not necessarily think that they ought to expect a different service from those in the other NERC community that receive funds. We certainly do place a large number of contracts in open tender which are won by the NERC institutions but also sometimes they are won by major university centres. So our contractual structure is typically three to five years for a contract but it is worth noticing maybe that the typical DoE research theme has a lifetime of maybe twice or three times that. We have been funding acid rain research now for over a decade in fairly well profiled expenditure terms. It is a little unrealistic, I think, for any institute or contractor to expect us to be able to lay out a contract in which we have managed to see our problem so far ahead as a decade and be sure that science remains relevant right to the end. I think that is our main delivery in terms of value for money, in fact, is the flexibility aspect of our programme. Chairman, I would like to emphasise that this type of logic is fine as long as there are other parallel tranches of funding that also support the science base. Clearly if you are going to have three-year contracts as the only way of doing anything, you will have very different concerns in infrastructure.

285. Have your average lengths of contracts with NERC been rising or falling?

(*Dr Fisk*) Chairman, subject to rechecking my data when I get back to the Department, I believe they have remained at about the same length over the last two years.

Chairman: Three to five years. Dr Williams?

Dr Williams

286. How responsive is NERC to your long-term research needs?

(*Dr Fisk*) There are a number of improvements that have occurred in the way NERC has been structured over the years, and without sounding too complacent, I believe that we are very close to a very good working relationship, probably one of the best that we have had for a very long while. Part of that has been an undoubted move to see the surveys and centres as important parts of the NERC community but not, as it were, preferential bidders for our funds. Therefore, NERC has become much more open to seeing that our policy needs define our research and that it is not necessarily there just to support NERC institutes. The consequence of that is that the NERC programmes themselves have become much more strategic, it seems to me, to run from both universities and the surveys and centres in an integrated fashion. We are very pleased to be consulted on the structure of those programmes. Very often our own officials give some contribution to those programme's formulation and they have been very good. I particularly mention, if I may, that the NERC has constructed, as you know, its own little technological foresight exercise. This was a very useful way of giving an extra dimension to the community that is around for consultation. I think we are very impressed with the way in which the NERC has responded to these types of challenges.

287. And when the nature of your contracts is relatively short-term, but they are changing the whole time, what about basic science within NERC? You did express some concern earlier as to the danger that there has been insufficient attention or insufficient resources to the core sciences?

(*Dr Fisk*) I was only expressing a concern that that was a danger and I was inviting the Committee to be vigilant, because clearly relying on contracts you could end up with such short-term science that you got no support at all. Many of the changes that have occurred in NERC, as we have observed them, have been to give a better user focus to some of its strategic programmes not necessarily ones for this department but for industry and other users. At the moment that is working very well. Clearly one could always over step that change but I would not have said at the moment that there are any signs that the NERC strategic programmes were coming down too short term themselves.

Mr Thompson

288. I am very interested in the whole question of the public understanding of science and the work done by the British Association for the Advancement of Science and many universities and so on. There is confusion in the area of climate change. Even in my own area of Norfolk I see little maps showing that my house will be submerged in the ocean in so many

[Mr Thompson *Cont*]

years' time. Who do you think should be responsible for promoting the public understanding of issues relating to climate and do you think enough is being done?

(*Dr Fisk*) The evidence that the Department has accumulated on its opinion polls of general reactions to the environment indicate that the British public's understanding of environmental science is tolerably good, measured against the base line of the sort of answer one usually gets about science questions to the public. The majority of the public picked the right option for what was the cause of global warming, the majority got the right answer for what causes summer time ozone smog and the next most popular, if erroneous, choice was one on which a lot of people could have made a mistake. We were not getting the more bizarre answers one sometimes gets when inviting answers on general science. The Department of Environment will try to explain the underlying science when inviting the public or industry to take action. We have often found it is better to get this information diffused by what one might call secondary sources. We have been supportive of COPUS in that sort of approach. British environmental journalists, particularly in the non-tabloid press, have a very high standard in the way they have reported issues, environmental issues and indeed some of them are international prize winners for the quality of the science journalism they do. If anything, the United Kingdom is slightly more favourably placed in environmental terms than some other countries. One point I would make is that it is also a very good opportunity for general public understanding of science. There are as many column inches on environmental issues as there are column inches on science.

289. Can I press you a little on that. Obviously the situation is quite good but we must not be complacent about public understanding of the issues. Do you think more could and should be done in spite of the very encouraging answers that you have given?

(*Dr Fisk*) Certainly in our renewed campaign to encourage people to save energy as part of the United Kingdom programme we will always endeavour to give some very short but interpretable reason as to why this would be a benefit and what the benefits would achieve. We have been very impressed with the type of environmental information put out to schools; and the Department does fund some third party agents to improve that information on the environment in general.

290. There are still hard decisions we need to take in this country in the area of improving the environment that we probably are not taking, so surely more must be done?

(*Dr Fisk*) Chairman, I can hardly disagree with that. I think the difficulty we always face in these issues is that the Department must not be tempted to exaggerate the possibilities that exist. In a sense our key objective is to get people to share with us the feeling that there are tremendous uncertainties but there is a case for a precautionary or an insurance position to take. What we do not want to do is to select only a part of the science (because that is what advertising agencies always want one to do) but try and maintain the very British position of sound science in what we say.

Chairman: Good question, good answer. Andrew Miller?

Mr Miller: Is the real difficulty in all of that though that some of the major issues you are facing cannot possibly be protected from the political process? You earlier on expressed some pride in the fact that in the international community our science is regarded as immune from the political process in areas, to take the example that Mr Thompson gave of his constituency being flooded.

Mr Thompson: Not all of it.

Mr Miller

291. His house as well. There would clearly be a difference of opinion even within parties in this Committee on, let us say, some of the energy issues. There are those of us who are strongly for and strongly against nuclear power. How do you in terms of promoting public understanding keep that independence from the political process?

(*Dr Fisk*) The broad principle we would use in any environmental debate would be to be very honest about the uncertainties. Secondly, to be clear that uncertainty itself is not an excuse for doing nothing. There are genuine risk-based decisions which have to be taken which, frankly, are sometimes of a political nature. They involve taking political decisions in the absence of full information with a particular view on how best to proceed. The example you gave of nuclear energy is a good one. In some parts of the world part the response to climate change has been to endorse existing nuclear build programmes. In others climate change has been a further challenge to an existing political decision to withdraw from nuclear as a major baseload electricity source. Those are essential issues for the public debate and for the political process and it is rather important that science is taken as the substance on which that debate is based but not actually, as it were, drawn into it.

Mr Miller: You will tell the Minister he is talking nonsense when he is talking nonsense on these things?

Chairman: You should not answer these questions.

Mr Batiste

292. If you substituted for political interference the pressures of political correctness and the fact that there has been this very big controversy lately in the United States where people who have a discordant view about global warming find it almost impossible to get publicly-funded research. What would be your view as to how we handle that here? Does your Department, for example, fund anybody that presents the proposition that global warming is nonsense, it is not happening and we are moving to an ice age?

(*Dr Fisk*) It is my impression that any sensible and challenging research programme would be funded by my Department if it was relevant to the goals I set, or, similarly for the NERC. After all, the Met Office model is the model that gives the lowest forward projections for global warming at the moment and we are not frightened about that. The American debate is a very remarkable and in many ways a

[**Mr Batiste** *Cont*]

rather depressing outcome of how an intelligent country can handle a difficult problem in a preposterous way.

Chairman: I like that very much; it is very good. Thank you very much for that answer. Dr Bray?

Dr Bray

293. There is perhaps a slight danger in assuming those problems could not arise in the United Kingdom. Should we be more concerned with the political understanding of science rather than the public understanding of science, in other words the knowledge that the Cabinet has?

(*Dr Fisk*) This is an area of science we have been discussing, Chairman, where the system is entirely open. There is no Hadley run that is kept secret, there are no research contractual reports we keep in cupboards and we have the advantage of a very wide public debate on all the research that comes out from our area. We have the advantage of again a very balanced public response to the Intergovernmental Panel on Climate Changes Report when it was produced. In that sort the environment I doubt there is very much distinction between the basis of knowledge on which a political decision is being taken and how the public debate itself is being conducted.

294. Can I pick up one point you said. You said in a recent international meeting there had been some United Kingdom success in initial steps toward establishing a panel on biodiversity of oceans. Does that exist on paper? Is there a record of that you can send to the Committee?

(*Dr Fisk*) I am happy, Chairman, to drop the Committee a short note on what was achieved at the recent conference on biodiversity so the Committee are able to judge what small gain I viewed as a triumph.

Chairman: Very good. Thank you very much, Dr Fisk, for being here and thank you for giving us a considerable amount of your time and the way in which you have answered our questions. We are most grateful.

Letter to the Clerk of the Committee from Professor Brian Hoskins, Professor of Meteorology, University of Reading, (19.6.96)

I am writing as Chairman of the Expert Panel that has recently produced a Report on a National Strategy for Global Environmental Research (GER) for the Inter-Agency Committee on Global Environmental Change. The report involves more than the area covered by NERC, but they are the key players in it. The National Strategy will be launched at the British Association in September. However, I believe that the Report may be useful for the Committee. Copies may be obtained from Mr S Morgan at the GER Office, Polaris House, Swindon.

As emphasised in our Report, the National Strategy is opportune because of the urgency of the problems. The reality of Global Warming associated with enhanced greenhouse gases is no longer officially couched in the language of "not inconsistent with". Stratospheric ozone depletion due to man made chemicals has occurred. In general, it is realised that we are running out of planet rather than out of resources.

Global environmental research covers a huge range in space and time. The impacts of global problems can be in extreme, local events. The characteristic behaviour of complex, interactive systems such as the environment is one of stability with sudden changes. Results can often be posed only as probabilities or risks of certain behaviour. However, the science has proceeded far enough that we know that very useful and important results can be obtained.

GER provides an information advantage in a changing world—giving an underpinning for economic activity in the global market and for policy development. In our Report we highlight areas of economic activity and the Technology Foresight that are strongly related to GER and discuss its relevance to the UK. The UK is involved in several hundreds of environmental obligations and arrangements and Government needs the best possible scientific advice.

At the Town Meeting to discuss our Report, many industrialists were extremely enthusiastic that such research was relevant to them and that it was "the sort of thing we pay taxes for".

The UK is extremely good at some aspects of GER, particularly areas related to NERC, and has an international influence far beyond the proportional expenditure in this country. There is no doubt that by selecting particular areas which fit well into the international and European programmes, the UK gains the advantage of a much wider research effort and great added value to its research. This statement carries over to facilities such as research aircraft. The MoD Hercules is complementary to the numerous other European aircraft and has been the UK's unique facility and its passport into international observational programmes.

The Global Environment will provide the intellectual challenge of the next few decades. It will need the brightest young scientists drawn from mathematics, physics, chemistry and biology undergraduate degrees. Crucial elements in this are the provision of sufficient postgraduate studentships by NERC to train them, and the attraction of a vibrant, basic research programme in which NERC funding is central.

There is a great danger that the current driving of the Research Councils is towards relevance where this is seen as local in time and space, in contrast to the strong message of our Report summarised above. The squeeze on NERC is now starting to put into jeopardy the UK programme, despite NERC funding already being at a level which is very small compared with the consequences of any environmental problems, eg the drought of 1995, or relevant industrial turnovers, e.g. reinsurance. For example, the eventual success rate of atmospheric science proposals in the USA to the National Science Foundation is about 50 per cent. With NERC it is now about 20 per cent, down from 45 per cent seven years ago.

Since I chaired the Atmospheric Science Committee of NERC when I was a Council Member and currently chair the Scientific Advisory Committee of the Meteorological Office, I should like to make a few specific comments on Atmospheric Science.

When NERC was formed the Meteorological Office stayed with MoD. Consequently the atmosphere was the only area in NERC without an institute. Initially, atmospheric science was a Cinderella in NERC, but by 1993 when I left Council, we were building up a high quality programme, complementary to the Meteorological Office effort, with very efficient distributed, university based structures. Since then atmospheric science in the UK has been under threat from two sides. The move to the Meteorological Office to Trading Fund status has meant that they are becoming totally focussed on applied research directly related to weather forecasting. The financial squeeze on NERC has led it to produce figures showing a dramatic decrease over the next few years in atmospheric science funding. Taken together, these developments could imply an extremely damaging impact on our world leading efforts in pollution, severe storms, ozone depletion, forecasting from hours to years, climate change prediction, etc.

Examination of Witness

PROFESSOR BRIAN J HOSKINS, Professor of Meteorology at the University of Reading, examined.

Chairman

295. Professor Hoskins, you are very welcome. You have, I think, been engaging at least from the touchline in the game of tennis that goes on and you are, I am sure, highly proficient in these matters. You are Chairman of the Expert Group?

(*Professor Hoskins*) I was.

296. I beg your pardon. You are the former Chairman?

(*Professor Hoskins*) I was very keen to make it a limited term!

297. That is probably right. Nevertheless, your reputation is secure as far as the Committee is concerned. You did publish, or rather your Group published, the United Kingdom National Strategy for Global Environmental Research, and so it would not be surprising for you if I said that we had some questions that we would like to draw from that memorandum. Would you want to make a statement yourself?

(*Professor Hoskins*) No, I am happy for you to start the questioning.

298. Very good. We understand that the DoE is formally in the lead, as you have heard. We have been probing Dr Fisk on that matter, but the Met. Office and NERC obviously have important responsibilities themselves. In addition, the Inter-Agency Committee acts as a co-ordinating body. To us as simple laymen in these matters this is a pretty convoluted structure. Is there not a need for a clearer lead to be given?

(*Professor Hoskins*) You must forgive me for being rather naive when it comes to these policy matters on high. I am a mere scientist.

299. You are good enough, I am sure.

(*Professor Hoskins*) I think the Inter-Agency Committee as it was formulated seemed to be able to do very useful co-ordinating work. I am concerned, as maybe you will be following up, that the Inter-Agency Committee is re-born with a very good leadership to make sure its work continues because I think it has lapsed at this time. So one of the things my Expert Panel had to do was to review the work that was going on in the various agencies and look for overlaps and gaps, and we did that and we drew a diagram which tried to show them all who else might be interested in the same area that they were, but I thought that the group around the table were able to act on what we produced and produce the executive moves that are necessary in that field, but we did feel as a Panel that there might be some other things that would be necessary. We did feel that in the global environmental research area it was going to be necessary to have some national committee for the science. There are various areas under the Royal Society but we felt that the Inter-Agency Committee and the Royal Society might be able to do that. Also, in our discussions with industry it became clear that there were a lot of industrialists who would like contact with what was going on in global environmental research. So the idea arose about some national forum again which would involve industry as well as perhaps IACGEC members and some scientists in terms of global environmental research.

300. But you did not find problems of overlapping between the various groups?

(*Professor Hoskins*) No. There are difficulties, I will not hide that, but I see them in my area of science. It is possible for a decision to be taken in one agency which influences the whole very seriously and yet that whole may not be looked at and that requires the IACGEC to be strong to actually look at such things.

Dr Bray

301. On the overall responsibility for inter-disciplinary research, your Expert Group had to deal with a number of different research councils which each had different past records and present commitments. Did you see any particular problems in trying to use that diverse resource? Would it not have been easier if you had had a more coherent agency to commission research?

(*Professor Hoskins*) I am not a great believer in general that a new structure will make life a lot easier. I think there is no doubt that there are great difficulties in the inter-disciplinary research that is

[**Dr Bray** *Cont*]

necessary and we had a group round the table in our Expert Panel. Initially I wondered whether this was going to work at all but in the end it turned out to be one of those really fruitful experiences of actually interacting with the scientists in the different areas. We struggled to think how such inter-disciplinary research could be pushed forward and we hoped perhaps with this national forum for science with scientists on board that they would strongly push and demand that the research councils produced what was necessary; let the scientists push on it and the research councils will respond. This is in general what we have found in the past.

302. Did your Expert Group have anything to do or say about the European Centre for Medium-Range Weather Forecasting?

(*Professor Hoskins*) I do not believe our Expert Group did. I could tell you a lot about it; I have been very associated with it, but I do not believe the Expert Group had anything to say about it.

303. So it did not add to the range of resources which your Group felt it appropriate to comment upon?

(*Professor Hoskins*) The European Centre, there is no doubt, does add to the United Kingdom and European resources in this area. The United Kingdom contributes to the European Centre and it is in Reading, two miles down the road from me, and we have extremely strong collaborations in the area of atmospheric modelling, and that is true for the British Met. Office as well. So it contributes very positively to the resources we have in this area. I cannot remember that it was actually something that we highlighted in our report.

304. What was the period which you covered in your term of chairmanship?

(*Professor Hoskins*) There was an initial period from September 1994 to December 1994 and we had a first Panel which hoped it had done all it was requested to do and resigned, as I tried to just now, and the IACGEC turned to us and said, "That's very nice. You have written the introductory chapter. Can you try again." So again from June 1995 through to December 1995 was really when we produced the report and then in the next half-year it was polished along with town meetings and discussions.

305. Did you have a precursor around the time of the 1990 Intergovernmental Conference?

(*Professor Hoskins*) No, we were certainly not active at that time, so we assumed all that was in place.

Mr Batiste

306. We have heard a lot about co-operation at the European level and at international level, both from yourself and from Dr Fisk, but are we getting as much as we could out of these programmes? Are we contributing as much as we could? Where do you feel we are falling short? Obviously nothing is ever perfect, so far as the co-operation in both directions is concerned, what could we, or should we, be doing more there?

(*Professor Hoskins*) Are you referring to European funding?

307. I am talking in the broad sense. We have not got any finite limits in what we are investigating but if would you like to take the European elements first and then look at the international ones and deal with them both separately?

(*Professor Hoskins*) If I could deal with the European-funded things first, there is no doubt that the United Kingdom does extremely well in terms of getting funding into the science in this country from the European programmes.

308. Which programmes pre-eminently?

(*Professor Hoskins*) These are the framework programmes, framework four I am thinking of. If you look at our success in that, then we are pre-eminent in that.

Chairman

309. Forgive me, this is an important point. You say that is pre-eminent in relation to what other members have attained?

(*Professor Hoskins*) That is correct, yes. The success rate is extremely high, which I think is a measure of how—

310. It is a qualitative judgement?

(*Professor Hoskins*) That is right. So certainly those are collaborative programmes and each of those involves collaboration with other European countries. There are a large number of other ways in which the collaboration does occur. I think it has always been one of the great interests of the subject that it is so international. The European Centre has been referred to. That is extremely productive as a way of collaborating. There is a joint programme with the French and Germans in terms of looking at weather systems in the Atlantic this next February. These sorts of programmes are always continuing. I think the European collaboration is very good.

Mr Batiste

311. Internationally?

(*Professor Hoskins*) Internationally as well. I think the United Kingdom does carry a lot of clout in this sort of area and I think if you take most of the sorts of research that go into the NERC area and into global environmental research, then you would find our relationships with the Americans were extremely good. I worried in the past that they were even better than the European ones and perhaps European relationships have come up to jostle with those recently.

312. What you are suggesting in your evidence is that we are doing everything possible in the best possible way.

(*Professor Hoskins*) I am sorry if it sounds too rosy. There are strains; of course there are. In the international area I think we are doing a good job so the collaboration is really very good. There are international programmes to look at the physical processes. Dr Fisk talked about the physical processes that have to be looked at to improve models and that again is an international thing. I am on the Joint Scientific Committee of the World Climate Research Programme. Again these are international programmes and one of the jobs of my

[Mr Batiste *Cont*]

Expert Panel is to make sure we do not try and do everything, we are picking off bits from these programmes that lead to synergy with the rest of the international programme and I think in general that works well.

Dr Williams

313. Could I press you a little on this question of international collaboration. As I recall, the United States used to be fairly agnostic about the effect of climate change back in the 1980s and if it is now the serious problem we think it is the implications for the United States' style of life, energy consumption and so on are more far-reaching than for Europe. Is that reflected in any way in their enthusiasm for research (or rather their is a little bit of a lack of enthusiasm or agnosticism) or does science overcome that?

(*Professor Hoskins*) At the research level one sees little sign of this. I was thinking when David Fisk was answering, often it is how you handle the uncertainty that is inherent in science that leads, as it goes towards the political level, to very different statements being made. There is uncertainty that is inherent is all this global environmental research. It is uncertainty associated with ignorance. It is uncertainty associated with the inherent nature of the climate system that has natural variability in it. Sometimes it comes closer to the political agenda of whether one high-lights the uncertainty or highlights the average conclusion.

314. I have another quite tricky global question and that is in terms of the carbon-dioxide sink. The oceans are at least as large a sink for carbon-dioxide as land masses. When it comes to research within the land masses for CO_2 sinks, every nation, especially advanced nations, can get involved in that research, but what about the oceanic aspect, is that sufficiently researched?

(*Professor Hoskins*) You will not find any of the scientists involved saying that it is and I would not off the top of my head like to actually pull out the comparative funding of the two and say they are in balance. They are clearly important to look at in both cases and there have been major international programmes to look at the draw-down of CO_2 into the oceans and there is importance for the continuation of that sort of work. There are international programmes and the UK contribution can be a varying one to those.

315. Is there a danger (because that type of research is necessarily more expensive and is offshore and in a sense is somebody else's problem rather than our own as it were, it is not territorial) that the oceanic aspect of the problem will not get sufficient attention?

(*Professor Hoskins*) I do not believe so. I think many of the atmospheric problems, for instance the work that United Kingdom scientists are doing on the Indian monsoon, may affect someone else more than they affect us directly. I think one of the challenging things about the global climate problem and global environmental research is you may be interested in what is going on here but what is going on everywhere is relevant to that.

Mr Miller

316. I asked Dr Fisk about money issues; I will ask you the same. The Expert Group contains a breakdown of publicly funded research in the United Kingdom into climate change. How easy was it to get that?

(*Professor Hoskins*) It was quite easy to get the figures from the various groups. And not because I have listened to David Fisk but because I would have said it anyway and I have said it in other fora and I think it is in the report, there are two extremes. One is you say, "How much of the research we are funding is in any way relevant to global environmental research?" and the other extreme is you say, "What change in funding is there because there have been these global problems?" and the two give such different numbers. I felt when we looked at what we got from the various research councils it depended how convenient the global environmental research bin was at that time whether it was convenient to their mission to say we are putting a lot into that bin or rather a little amount.

317. That leads on to the second point I want to press you on. The total given includes research for other specific purposes like looking at Mr Thompson's house, coastal protection issues or satellite sensitive areas. Can you give a rough estimate of how much is spent on projects whose primary purpose is to study climate change?

(*Professor Hoskins*) Could I ask you a question in return? If I am studying a particular weather system, should the net effect of all those weather systems being important in climate and therefore having to be represented in climate models, be included or not!

318. What you are saying is that it is not easy to compile the list in a meaningful way?

(*Professor Hoskins*) I do not think you can. David Fisk was broadening the agenda earlier to include natural climate variability. I would broaden it further to say there is a seamless web through to weather itself because climate is the net ensemble of weather. I can tell you there is not a single climate model in the world that has had a major variation of the earth's atmosphere on a timescale of 40 to 60 days. Can we believe them because of that? I do not know.

Chairman

319. The judgements that have to be made certainly at government level and NERC level and DoE level are all the same; it is a question of the allocation of resources. When the problem appears to be infinite, not only infinite but inter-connected we have to arrive at a decision on priorities in relation to these aspects. Have you any view or general guidance from the work you have already done to comment on how this is best achieved?

(*Professor Hoskins*) The Expert Panel produced a framework rather than a detailed strategy with a prioritisation. We felt that in the context of the United Kingdom and the IACGEC that was the right way to go about it. We gave a context which we believe helps the research councils to do that prioritisation.

[**Chairman** *Cont*]

320. You would expect them to do the prioritisation?

(*Professor Hoskins*) On the basis of the framework we produced and bring back to the IACGEC how they were doing and how the programmes fitted into this.

Mr Miller

321. Because of all these complicated overlaps between programmes (and sometimes presumably you start on a project and do not realise that the consequences of it may be directed elsewhere and perhaps to another department) would you agree with Sir John Houghton that the lack of a department with a clear lead responsibility has led to under funding or waste and perhaps an ineffective use of funding of research into climate change?

(*Professor Hoskins*) He said that did he? I do not think that there has been waste in this area. I think the worry more I have, listening to David Fisk, was yes the DoE can come along and say, "This is our new problem", but the job for NERC is to make sure the basic research has been done such that when DoE or D of Health comes along the research is there to which we can respond. The danger is, rather than directing it through on the global environmental problems, whether there is the basic research that is necessary to answer tomorrow's problems.

322. You would not necessarily agree that there should be a lead department?

(*Professor Hoskins*) As I said at the beginning, I think I have a certain naivety in the higher levels of organisation in this, says he falling back! I think that the current structure can provide the United Kingdom with a very efficient job in this area and my worry is more that the basic research for tomorrow's problems continues to be funded and the pressure on NERC is not always to produce the deliverable for the now but is producing the basic research which will answer tomorrow's problems.

Mr Thompson

323. If I could come in on that point, I tend to feel all the time in discussion of this type that we are concentrating too much on the structure and not enough on just the need for more research. Unless I have misunderstood you, that is exactly what you have just said in the last few moments?

(*Professor Hoskins*) Could I expand on that and give an example from my area. Is it a success for NERC atmospheric science to produce basic research that is then applied by the Met. Office? In the current ideas of consumer and deliverables, this is not looked on necessarily as such a success as if you helped some company produce some screw or other. However, this has to be a major thing for NERC to do, to produce this science, and it has to be a success that it has produced the basic research that the Met. Office or whoever can apply.

Mr Batiste

324. But to go back to what I was saying before, taking your seamless robe example, what you are basically saying is that because none of your models can run more than 40 days and then produce forecasts or whatever, you simply are not yet plugged into enough sources of information and knowledge to be able to make predictions, for example, not even within the range of NERC, but the aborted Cluster programme designed to produce the information would have been something that might have had a profound impact on making longer-term forecasting and a whole range of things? From what I am gathering from what you are saying, you are able, as it were, to draw a parallel, judging current symptoms and being able to make predictions from current symptoms, but to get much beyond where you are, you actually have to be plugged in in so many different ways in different directions and it is still a very long way ahead?

(*Professor Hoskins*) There are useful things that can be produced now from global environmental research. So it is not all jam tomorrow, but it is something where the climate system and the global environmental system are such complex systems and I firmly believe that the real intellectual challenge for science in the next few decades is to further the understanding of this. We have been dealing with a lot of other scientific problems for many years but I think the complexity of those is minor compared with the system we are dealing with.

325. Coming back to the Cluster programme for a moment, it is one that we looked at in one of our previous reports. How significant would the information that the Cluster mission was designed to achieve have been for you?

(*Professor Hoskins*) As I understand it, that was to do with the ionosphere and the magnetosphere. To be honest, I would not call that the most pressing problem for us at this time. It has importance. However, if I were producing my priority list for this it would not be the No. 1 priority for this *per se* but it has clear scientific interest and many applications.

Dr Williams

326. Could I come in on this very angle, as it were. I notice in the table that added up to 180 million in terms of research relevant to climate change, one of the big contributions there is British National Space Centre, 53 million, and there is only one line of explanation for it in the briefing we have had. How much of that is really and truly relevant to climate change? Is that a little bit like the Cluster programme again? Is it a bit misleading to include that as 53 million? A fraction of that 53 million might be a more accurate investment?

(*Professor Hoskins*) I am afraid I cannot give you a good answer on that. I suspect that a large part of it is associated with environmental research, as I would understand it, global environmental research. I think it does come back to a point that you were pressing Dr Fisk on, that satellite instrumentation is so expensive and the data is so expensive that it really behoves us to make sure we add that little bit of extra money always to make sure we get everything we can

[**Dr Williams** *Cont*]

out of that data. So it is not just making sure that we get the data from other countries, etc. It is actually making sure that where we do have a data stream we put that data alongside all the other data that we have, or the theoretical ideas and the models we have, and gain every bit of value out of that data because it is so expensive to get.

Chairman

327. Professor Hoskins, can I ask you a question which relates in part to what Dr Fisk was telling us. He seemed to have made the assertion that NERC had become more strategic? Is that something with which you agree? Is it necessarily a good thing that that should be so?

(*Professor Hoskins*) I was on NERC Council some years ago and we were always prioritising research in terms of what we thought was necessary for the United Kingdom and the best strategy to have. So I would say that NERC was doing good strategic work at that time and I think it is continuing to do so. So I am not sure that I see necessarily a change. I think that NERC has done that strategic work over many years.

Mr Thompson

328. The Climate Agenda suggests that there is a need for more observational data and consequent improvement of systems to collect it, and last week we had Professor Hunt tell us that better use of existing data was as important as, or more important than, new systems. What is your view on that?

(*Professor Hoskins*) As I have suggested to you, I think that getting everything possible out of the data streams we have now is the No. 1 priority. If we were told that we would never get any new data sources, we could get quite a lot out of the present ones. However, that is not to say that in order really to deal with the system in a better manner we will need new data sources. I agree with Dr Fisk that I think John Houghton's timescale is really the timescale of satellite programmes, which tends to be 20 years, whereas many of us are concerned with actually safeguarding the data streams that are currently there and making sure we really, in the next five or ten years, get everything we can out of those data streams.

329. So do I understand you to say that, although our data collection is adequate at the moment, that does not mean that it should not be improved, and can I couple that with asking what would be lost if the research aircraft were no longer available or if its use was severely restricted, which we have also discussed before?

(*Professor Hoskins*) I will start with the data one in general. When we are designing the future observation systems we have to mount very careful campaigns with models and theory to make sure we are getting the optimum data possible. There were times in the past when one felt that someone said, "I have an instrument, let's fly it," and then they would come along to the modelling theoretical community and say, "Right, you use it," whereas I think now we have reached a situation where it is being driven by those who are trying to understand the system and interacting with those who are designing the sensors. So I am content that the right sorts of things are happening for those future observation systems that will be necessary. Dealing with the aircraft itself, that is one where, as I hinted before, decisions can be taken in one agency, this time the MoD, which have a very deleterious effect on the whole global environmental research by the United Kingdom, but in terms of their priorities at that time, this was the right decision to make. There have been a lot of discussions since then in terms of trying to keep the United Kingdom's access to such an aircraft and it has been a passport to many international programmes. It has been important for calibrating the ways of properly using satellite data and it is important for looking at local processes that go up, integrate up, to the large length scale. The deliberations on the aircraft of course come in with NERC being told, "You should pick up the tab on the aircraft," but the money was taken from the Met. Office budget in the first place and I think it puts NERC in a very difficult situation to handle this, and I can say that now because I am really outside the NERC ambit.

Dr Bray

330. On this same field, you do in your report refer to the problems of providing data on radiation, clouds, aerosols and so on. These are all, in fact, covered by the aircraft?

(*Professor Hoskins*) Yes, and we have a very good test bed there that has been developed over many years and has, in a European context certainly and probably internationally, a unique spot.

331. If you look at the different areas from which data is drawn on global environmental change, etc., submarine, ocean surface, coastal fringe, terrestrial, lower atmosphere and upper atmosphere space, where are the biggest gaps in the observations?

(*Professor Hoskins*) I think I would start with the comment I made previously, that we have certain data streams at this time and our first obligation is to ensure the continuance of those, and it is only after that that then I can say we should look for the new ones. Clearly, looking at the world's oceans is a very difficult job if one is really going to plumb into the depths of the ocean to look at what is going on. So there are huge data voids in terms of the oceans and I think it is going to be an important thing in terms of the modelling and theory to see just how much we have to get into the ocean to observe it on a real-time basis. There are many things that, for instance, may be put in place for, in the first place, weather forecasting that will actually help in the climate area. There are new satellite instruments that will be looking at winds, for instance, and that data will be extremely useful for tomorrow's weather forecast but it will also feed very strongly into the climate work.

332. Is there not a complementary danger that observations which are not useful for weather forecasting but might be very important for climate change get neglected?

(*Professor Hoskins*) Yes, I think that is correct.

333. The obvious example there is terrestrial observation?

[Dr Bray *Cont*]

(*Professor Hoskins*) Yes. That is another area where we hinted in our report that decisions may be taken under the Prior Options actually to do something to an institute and not take care of the observations that are contributing to the climate question.

334. Looking at the international contributions to this, the observations, terrestrial maybe, are the ones that can be made by developing countries at relatively low cost and are very relevant to their own environmental problems. Is this an area to which United Kingdom scientists ought to be giving more attention?

(*Professor Hoskins*) In terms of helping other countries?

335. In terms of creating an international research capability where the overall common problem can be addressed?

(*Professor Hoskins*) I think United Kingdom scientists have been very active overseas, certainly in the experimental framework of taking terrestrial observations, and I know the Panel that I chaired thought that the overseas part should be put higher than it has been on the agenda. In terms of the political decisions that will need to be taken and in terms of the climate observations that need to be taken, we have to involve other countries and the United Kingdom has had a good record in terms of training people from other countries and interacting with the scientists there and I think there is certainly a good role that we could play in that.

336. The Tiger programme of NERC has done recently announced work on carbon absorption in peat bogs and so on, and while we have some peat bogs in this country, globally the overwhelming masses of them are in Russia, Finland and Canada. Would it not make more sense for a United Kingdom programme in this area in fact to have addressed those areas, experimented in those areas, rather than mainly in the United Kingdom?

(*Professor Hoskins*) There clearly is an expense part to that and if one can do the research locally then that is clearly helpful. There are very competent scientists in Canada and in Russia who I am sure the terrestrial scientists here will be linking with and who will see the results of the science that they put out in the international journals. So I am sure that the linkages will be there and it is a case, I think, where, if you do a piece of research locally, you can probably extrapolate to other areas and certainly link with the science that should go on in those areas.

Chairman: Thank you very much, Professor Hoskins. We have now reached the end of our session with you. We are very grateful for the information which you have given to us and, if I may say so, for the position of authority and independence with which you are able to speak to us. Thank you very much indeed for coming.

WEDNESDAY 15 JANUARY 1997

Members present:

Mr Spencer Batiste	Mr Andrew Miller
Dr Jeremy Bray	Sir Trevor Skeet
Mr Ian Bruce	Mr Patrick Thompson
Mrs Anne Campbell	Sir Gerard Vaughan
Dr Lynne Jones	Dr Alan Williams

(In the absence of the Chairman, Sir Trevor Skeet was called to the Chair).

Letter to the Clerk of the Committee from Professor Peter Liss, School of Environmental Sciences (19.8.96)

This letter is written in response to the Press Notice of 23 May 1996 asking for submissions to the above inquiry. I am writing as a former member of the NER Council (1990–95) and also as Chairman of the International Geosphere-Biosphere Programme (IGBP) of the International Council of Scientific Unions (ICSU). My remarks will first be about the current internal organisation of NERC and then on the type of research the Council is pursuing post the 1993 White Paper ("Realising Our Potential").

In summer 1994 the Council's Science Committees and the corresponding Directorates of Science were replaced by six Science and Technology Boards under a single Director of Science. I saw both organisational structures in operation as Chairman of both the old Marine Sciences Committee and the new Marine Science and Technology Board. The overriding impression of the change is that the Boards are largely impotent, since they have neither budgets nor executive arms, and function essentially as talking shops. Members are frustrated at their powerlessness; they set priorities only to see these overturned at the next decision making level (Resources and Strategy Group). I would not necessarily think a return to a full Directorate structure is the best way forward. However, programme managers for the various parts of the Council's science portfolio are definitely a requirement, in my view. They would need to have executive authority to carry out the decisions of the Science and Technology Boards, under the overall scientific and budgetary control of the Council. Programme managers would not necessarily be full-time appointees.

A related matter, but specific to the marine sciences, is that of the Council's three ocean-going research vessels. These have been under-funded for a number of years so that they now go to sea for only a fraction of the total time potentially available. This is not for want of highly-rated science proposals to use the ships, just that insufficient funds are allocated for full utilisation. This is a great shame since the vessels are both scientifically and operationally amongst the very best in the world.

Turning to the NERC research agenda post White Paper, there are serious concerns in the scientific community that the paper's aims have been accepted uncritically and somewhat naively by the Council. Although the phrase "wealth creation and *quality of life*" runs through the White Paper, the italicised part has to be interpreted with at least as much seriousness as wealth creation, particularly by the NERC. It is not just a matter of working on those parts of the environmental sciences which can generate or, more often, save money close to home and in the short term. Unless we worry about the long term and the globe as a whole, efforts at wealth creation may ultimately prove pointless. In the rush to try to make NERC science conform to the White Paper's *presumed* objectives, some thematic programmes have been created where the science is not at the cutting edge, the responsive mode appears to have been starved of funds, and the Council's commitment to international programmes in global change has weakened. The NERC's fundamental task is to ensure that the UK science base is well supported; it should not be in the business of spending significant amounts of its basic science funds in those areas where others, for example the Environment Agency and industry, are both better qualified and motivated.

Letter from Dr Phillip Williamson, School of Environmental Science, University of East Anglia (21.11.96)

Yesterday's public session of the S & T Committee was of great interest to me, since I was closely involved in preparing the UK National Strategy for Global Environmental Research. The interviews with Dr David Fisk and Professor Brian Hoskins constructively addressed a wide range of scientific and structural issues. Nevertheless, in my view, some important aspects did not seem to be well covered. In partcular:

1. The hiatus in activities with regard to the Inter Agency Committee on Global Environmental Change (IACGEC), that formally ceased to exist after its May 1996 meeting. I understand that OST, via its Chief Scientific Adviser, in now consulting with relevant bodies (including the Royal Society) on the mandate and

structure of a re-established IACGEC, with a new Chairman. The S & T Committee might wish to obtain further information on this exercise, in view of the consensus yesterday that the IACGEC had a key co-ordinating role; eg for action on the National Strategy.

2. The problem of funding global change research under NERC's thematic funding mode. Major initiatives (such as WOCE, TIGER and LOIS) have, to date, greatly benefitted from such support. As a result, there are now strong pressures that future thematic funding should be directed at issues other than global change. However, the interdisciplinarity and complexity of such research make it essential that careful co-ordination of the national effort should be maintained.

3. Yesterday, international aspects were primarily considered in the context of EC funding, and DoE's (governmental) role in IPCC, without much regard to non-governmental linkages between UK research and work elsewhere. One criterion for identifying research expenditure that international research activities (such as the World Climate Research Programme, WCRP and the International Geosphere-Biosphere Programme, (IGBP) that are closely aligned with the IPCC review process.

4. The enquiries of the S & T Committee have, to date, focused on research on the physical components of the climate system (the area of Professor Hoskins' expertise, and of previous witnesses). Whilst I appreciate that the committee must set limits to its current enquiry, it should be aware that the climate system is strongly affected by biologically-driven feedback processes (eg via the carbon cycle). Reference to international programmes may also be useful here, in helping to define the conceptual – as well as financial – boundaries of climate change research.

The National Strategy provides further discussion relevant to (2) – (4) above. The Committee might also wish to interview other witnesses with expertise in these topics, eg Professor Peter Liss.

Examination of Witnesses

Professor Peter Liss, University of East Anglia, and Dr Phillip Williamson, Centre for Coastal and Marine Sciences, NERC, examined.

Sir Trevor Skeet

337. Professor Liss and Dr Williamson, you are most welcome. Would you like to outline the sort of research that you undertake and say how this fits into the portfolio and also indicate the international context with respect to the Intergovernmental Panel on Climate Change?

(*Professor Liss*) It is my pleasure to be here this afternoon and to be with the Committee. My own personal research is concerned with ocean atmosphere interaction, particularly the exchange of gases between the ocean and the atmosphere. That includes both the uptake of carbon dioxide, both natural and man-made, by the oceans and also the production by marine organisms, by the plankton, of gases like dimethyl sulphide which then move from the oceans into the atmosphere where they affect the atmosphere's chemistry and potentially the climate. In remote parts of the world this cycle of dimethyl sulphide being produced by plankton and going into the atmosphere is a source of the cloud condensation nuclei which control the cloudiness of the planet in remote locations, so that is my area of research. It fits well into the NERC's portfolio because, you see, it is ocean and atmosphere interaction work and the NERC has a Marine Science and Technology Board which covers marine sciences and it has an Atmospheric Science and Technology Board which covers atmospheric sciences, but for the funding of responsive work it has a combined committee which deals with oceans and atmosphere, so it fits well into the structural arrangements for funding in the NERC. Turning to the international level, I am Chairman of the Scientific Committee of the International Geosphere-Biosphere Programme, IGBP, which is one of the three programmes which constitute the international effort at the research level to deal with global change. There is the IGBP, being the International Geosphere-Biosphere Programme which I have mentioned, there is the World Climate Research Programme which is more concerned with the physics of global change and physical modelling, and also the International Human Dimensions Programme which is concerned with the more social science aspects and which is really at its formation stage at the present time.

338. Dr Williamson, would you like to add to that?

(*Dr Williamson*) Just in brief summary, to say that I am employed by the Natural Environment Research Council, I am based at the University of East Anglia, and I have worked with the international programme that Professor Liss mentioned, IGBP, where I worked with them for two years in Stockholm as Deputy Executive Director of IGBP. My current work, based at the University of East Anglia is on the programme development, policy and planning, particularly within NERC with the Centre for Coastal and Marine Sciences, which is CCMS. For that part of my work, I am answerable to the Director of CCMS and that is within the NERC structure. For that, as I said, it is the programme development and public relations aspect rather than my own personal research.

339. Thank you very much. Professor Liss, can I ask you a general question? Your experience as an oceanographer will be extremely valuable. One or two of us are perplexed by the fact that we read in the *New Scientist* that in the past 400 years temperatures have gone up by one degree centigrade only. Are we in an age of global warming or should we not take a longer time-frame?

(*Professor Liss*) Certainly temperatures over this century seem to have gone up by about half a degree centigrade which may not seem very much to us, but

[Sir Trevor Skeet *Cont*]

it is quite substantial in terms of the speed at which that change has occurred. Changes of that magnitude and more have certainly occurred between Ice Ages and inter-glacials in the past, but they have taken many hundreds, if not thousands, of years to take place, so the man-made increase, which is now attributed to man at least by the IPCC process, is a very rapid change, although as yet it is rather small in size.

340. But if you take a longer time-frame, would it not indicate with the cold terms and the hotter eras that the average would come down?

(*Professor Liss*) Well, of course you can always average things in such a way as to get different numbers. What I am saying is that if you take the average over the observational record we have, the rate of change is very rapid at the present time, and if you average that and say, "Well, okay, that increase, we will average it now over 1,000 years", then of course the rate of increase does not look so great. You have to look at the appropriate time period to get a meaningful average.

Mr Bruce

341. With that half a degree you were talking about, it seems to me, as a very "knife and fork" scientist, that half a degree, surely that is beyond the levels of accuracy that one could actually be assured?

(*Professor Liss*) Well, I have been in this sort of situation before. In fact on an American television interview, the interviewer asked the same question and said, "Well, half a degree", and we were actually talking about a doubling of CO_2 then and where the increase might be two degrees, he said, "That does not sound very much to most people", and I was with an American colleague who said, "Well, I have to point out that he is talking about degrees centigrade and if you put it into degrees fahrenheit, of course it sounds like a lot more!" To tell the truth, the measurements are now very extensive and that is why I concentrate on the last period of this century where the measurements are much more reliable. If you go back in the past where the measurements are much less reliable, the instrumentation was not there and the observational sites were not being properly set up, but in this century there are a lot of observational sites and the data is inter-calibrated very carefully. In the University of East Anglia, we have Climatic Research Unit where people spend all their research careers worrying about how to deal with the data stream that is coming in. The IPCC report, which I am sure you are all aware of, which was published last year does say that we can now see in the records the influence of man burning fossil fuels and other changes in respect of the composition can be seen in the observational records. I think that is a very important step and ten years ago if you had asked me the same question, I would have said that action will not be taken until the observational records show that there is a change because people, quite rightly, are suspicious or sceptical about simple models, mathematical models which clearly do not take all the factors into account and the scientists would not claim that they can because the system is too complex. However, once you see in the observational records things which are more than you would expect from the noise of the system then you have, I think, to sit up and pay attention and that of course is what is happening through the IPCC process.

Mr Batiste

342. We had some fascinating papers circulated to us about some tree-ring research which alleges that it can provide much more accurate temperature analysis of changes in the climate going back over a millennium than has hitherto been thought possible and if I read it right, it seems to suggest that at particular times there have been quite sudden changes in temperature and that, therefore, it is still very, very premature to suggest that the changes we are seeing now are directly the consequence of man-made actions as opposed to perhaps man-made actions coming alongside some other trend that may be happening, but which we are not predicting or not picking up. Would that be fair?

(*Professor Liss*) I think that is fair comment. Science is always full of surprises and that is one of the fascinations to those of us who earn our living doing it. It is true that not only tree-ring records but some of the ice-core records which have been analysed in much more detail in recent years do show periods when the cooling or warming has been much more rapid than people thought previously. It is still not as rapid as the changes that we have seen this century. It may put a question mark but it does not undermine the consensus. The IPCC document, if one reads it and hears the scientists speaking, the analysis they have done is not just looking at temperature records and saying it is going up more than you would expect from the noise we see in the system as a function of its normal operation. They have been very sophisticated and looked and said that if the rise is due to greenhouse gases does that have a special significance? Do you see greater temperature increases in one place than another? Do you, for instance, see a rise in temperature in the troposphere at lower levels of the atmosphere but also an equivalent cooling at higher levels? That is what you would see if the warming is due to increased levels of CO_2. If you look vertically you can confirm the system is doing what it would do as a result of CO_2 increases not what it would do as a result of some other perturbation. Similarly, you look at the northern hemisphere temperature change as opposed to the southern hemisphere and again you can see that the rate of increase is less because of the sulphate aerosol which the burning of fossil fuels has brought into the northern hemisphere but not yet the southern hemisphere to any degree.

343. You would suggest that it is a nasty cynicism we have as politicians that people whose life's work is based upon the proposition that there is global warming caused by man will fairly naturally lead to research results that will support the continuation of that research?

(*Professor Liss*) Yes, that is cynical. You could say, if I was to be similarly cynical, that a scientist will actually gain more funds by in a sense supporting the opposition because the opposition has more money than research councils, so I could turn the question.

[**Mr Batiste** *Cont*]

(*Dr Williamson*) Could I comment on natural variability, the argument of whether or not we are seeing a human influence on natural variability. The work over the last ten years or so has indicated how variable the system has been in the past. It might be more than 10,000 years ago but in terms of the earth's history that is nothing at all and to know that the earth's system can exist in various states under natural forces, it can flip and change and go from one to the other. For the last 2,000 years we have had it pretty easy and the climate has been remarkably stable. Therefore, if we are seeing some perturbations, some change now, it might be natural or it might be that we are tipping it one way or the other. This is when one puts it in the larger system and says how does the system work. The difficulty there is of separating the human from the natural. It is not easy but one has got to be aware that the natural system is inherently variable and we might be a triggering the natural one in some way but that has probably been discussed.

Dr Williams

344. You did say earlier that the measurements are getting increasingly accurate as science advances and as we realise more and more that there may be a problem here. Do the measurements show in the second half of the century there has been a marked increase in global than in the first part of the century and if you take 1950, 1960, 1970 and 1980, is it a steady rise or is the actual increase getting larger decade by decade? Is it accelerating?

(*Professor Liss*) In general terms it is accelerating but the record, even though it is rising, does show faster and slower rates of increase. Some of this can be attributed to oceanic processes because years when El Nino is stronger or weaker certainly has an effect on the rate of temperature increase in the atmosphere. There are some unexplained phenomena. For instance, there was a cooling in the 1940s which is not well explained so there are plenty of things we do not understand about the system. It is variable so one has to be very careful. I did not want to give the impression that we understand the system perfectly. But I think you asked me about the IPCC specifically and I omitted to mention in my introduction that that process has brought together essentially all the scientific knowledge there is in the whole globe on this issue and they have come to this conclusion. It is very hard for any individual or group of people to say that is wrong. They have to assemble a similar magnitude of opponents in order to argue the negative case. It is difficult to escape the conclusion that the IPCC has come to.

Mr Miller

345. If I could move us on to research priorities. If we stuck on the actual subject that we have touched on just now we could be here a very long time. It would be extremely interesting but would not help us complete our report. I think you have been in the past a member of the NERC Research Council and of course a member of that general research unit for rather longer. In the course of that time, do you think that NERC has had to expand its activities as other government departments or agencies have withdrawn from areas of science they formerly supported? Could you give us any examples of that and what is your general feeling as to whether that is a satisfactory route for the planning of science to go through?

(*Professor Liss*) I think the point you are hitting is an accurate one because over the last ten years, I suppose, several governmental type laboratories, if I can call them that, have either been closed or they have moved to other agencies. I give as an example the Central Electricity Research laboratory at Leatherhead which used to be one of the research arms of the CEGB. I am not aware that that research activity which was at a very high level both in quality and quantity has been transferred to some other agency as a result of privatisation.

346. AEA Technology.

(*Professor Liss*) There is another example I was going to give. The Harwell laboratory which used to be very strong on basic research as well applied, in a sense they have been moved in a direction where they have to be much more applied and near market research than formerly. This in some instances has benefitted the universities because several key scientists have moved from Harwell to the universities. We have recruited one in my school of Environmental Sciences at UEA university. They are not lost to the system but what I am saying is the research capacity of several bodies has been decreased over a period of years and inevitably that has meant that the call on the research councils to do research has correspondingly increased. I think that is inescapable.

347. If we look at work currently undertaken by BA Technology, which happens to be in my constituency and was a former part of the Electricity Research Council operations, yes, it is true to say that their activities do not represent the earlier core research activities of CEGB but nevertheless they are extremely active and doing some extremely important research in a very wide area into things like sick building syndrome. Has it meant, therefore, that those activities that were core to the CEGB's research programme have been pushed on to you and the new independent research councils and has BA Technology simply gone off and done things that are commissioned by the private sector?

(*Professor Liss*) I think the second is correct although I do not know the detail of the research laboratory you are describing. I have never done an audit of it so it is hard for me to take a general and informed view. All I do know is that in the past when there was a research laboratory at Leatherhead which was funded by the CEGB we had a lot of contact with them and we did a lot of joint research. We are not now doing joint research with the BA Technology Centre you mentioned. I can only give a personal view on that. You have to judge that as a fraction of the total effort in that institute.

Dr Jones

348. I just wanted to come in there. Have any recent changes at the Met Office moving to a trading status perhaps put constraints on the Department for the Environment programme and have they had an effect on research in this area and is it of any concern to you?

(*Professor Liss*) Well, can I just deal with the Met Office because I think the one area where that has affected the research councils is with the Met Research Flight, and of course I have read some of the evidence you have had from others and I think you are aware of this situation. I think the research councils are being charged £6,000 an hour for the use of the Hercules, whereas previously it was essentially free, so those sorts of changes clearly make difficulties when the science budget of a research council is essentially pegged. It is certainly not rising and it may even be falling in real terms.

Mr Batiste

349. Could I take you to that passage in your evidence where you said, "In the rush to try to make NERC science conform to the White Paper's presumed objectives, some thematic programmes have been created where the science is not at the cutting edge and the responsive mode appears to have been starved of funds". I have several questions, if I may, about that. First of all, you talk about the White Paper's "presumed objectives" and it is the "presumed" that I am interested in. Do you suspect that there is a set of objectives which are not stated in the White Paper?

(*Professor Liss*) No, I think what I meant by "presumed objectives" was that people have interpreted the White Paper in a certain way. Whether that was the intention of the people who wrote it and voted for it, it is not clear to me. I think from my perspective the interpretation may have been too rigorous or too strict and maybe that was not the intention of the Government when that White Paper was voted on.

350. I am having a little bit of difficulty with that concept. It may help us if you could give us some examples of what you are talking about and help me fix exactly what you mean by this.

(*Professor Liss*) Well, I think that first of all you have mentioned the responsive mode which I have mentioned in my evidence. I think that from the workbench point of view, the difficulty of getting responsive mode money, that is the money which is in a sense for "Blue Skies" research as proposed by university researchers and now institute researchers, is becoming harder and harder to get. It is hard for me now not on the Research Council, where I had been for five years, but came off a couple of years ago, to know exactly how the books are now being balanced, as it were, but the perception at the cutting edge, if you like, where we are doing the work, is that it is getting harder and harder to get money.

351. Let me ask you for your perception. Of Alpha-quality responsive mode applications funding, what proportion get funding?

(*Professor Liss*) I think it is 20 per cent at the present time and I would contrast that. When I was on the Council, we had a target and I think it was that 75 per cent of Alpha-graded science should get funded. We seldom made it above 60 per cent and we fretted as to whether we should change the target or whether we should try harder to fund more university-type research. Now, I talk about a figure of 20 per cent which seems to be a big difference.

352. Is that in a sense a switching in funding priority or the fact that this has become a politically much sexier subject, so there are a lot more projects coming forward?

(*Professor Liss*) Well, no doubt there are more proposals coming forward, although not a huge number more, although we have many more universities now which are expecting to do research and get research money from the research councils, so there are more proposals, but I reckon that is probably not more than a 20 per cent factor. I have been on some of the NERC committees many years ago and from what I hear of the numbers they are dealing with now, maybe it has gone up from 40 per grant round to 50 per grant round, so I do not think the effect is huge, but there certainly is an effect from the increased number of applications. Of course the cost of research has gone up and it must be that the budget has not risen for that section of the research council work to meet the increased demand.

353. Your basic criticism, if I understand it right, is that the thematic programmes have got money which potentially does not fund Alpha-graded programmes at the expense of the Alpha-response programmes, but is there not also a case for saying that NERC has to find a broad spread to attract across the country a rather full range of skills and that indeed part of its mission is to place "special emphasis on the needs of the users of its research and training output" and is this not actually part of a coherent strategic approach?

(*Professor Liss*) Yes, I think clearly NERC and all the other research councils have to respond to the White Paper objectives. I think the point I am making is not that I have a particular objection to that, but that the way it has been done or the result of it is that some of those new proposals, some of which were prepared in considerable haste, have in fact been of lesser quality science, less imaginative science than some of the programmes which they displaced. NERC for many years has had the equivalent of thematic programmes and they were called "community research programmes" then and essentially the money for them came as a result of the PES round of bidding, with which I guess you will all be familiar. So new money came to the research councils if they won at the PES round because a certain percentage of the total science budget was held back and ABRC allocated it to the winning research councils and those who won got more and those who lost got less. Those monies were, new monies, not baseline funds, they were given for certain years to do a certain task, then reverted to the baseline, and were for proposals which had to fight with other research councils' proposals to get that money and, therefore, only the very best would get through and win, so that was a highly competitive system. Now, the PES round, at least as far as NERC

[**Mr Batiste** *Cont*]

is concerned, does not seem to be a way of getting additional funds, so the thematic bids are being funded from the old community programmes when they come to an end. That means there is rather a smaller amount of money because with inflation, et cetera, at the end of a five-year programme, although it might have funded a lot of science in the beginning, by the end of the programme it is funding much less. Therefore, the amount of money available to fund the thematic programmes has gone down and there has been a scramble to generate ones which will fulfil the White Paper objectives and some of those, I think, have not been formed from the best science.

354. And your view is that some of these programmes which are now backed ought to go to the Environment Agency and be funded by the industry?

(*Professor Liss*) Well, I have had conversations with people in the Environment Agency who have said that very thing to me. A member of the Environment Agency expresses his view as, "Well, you know, we are being asked to fund these things which really should be funded by the Environment Agency", so I think yes, there is an element of that.

Mrs Campbell

355. Nevertheless, Professor Liss, some of the science research funds have been top-sliced and removed for things like ROPA awards, just to quote an example of that. Now, do you think that there is any worthwhile research being done under the heading of the ROPA awards which would be a substitute maybe for some of these losses in the thematic awards that you are talking about?

(*Professor Liss*) I am not well aware of the outcome. I know the ROPA scheme quite well and in fact I tried to apply for money for myself, but I found I did not obey the rules which were very strict at the time that I applied and I am not very clear on the outcome. I have heard some criticisms of the early round at least that the proposals were not well peer-reviewed or not peer-reviewed as thoroughly as responsive-mode science, but maybe that is a bit of history and now the system is more strict.

356. I just wonder if you are aware of any research being done under the aegis of the ROPA awards which might have substituted for some of the thematic awards.

(*Professor Liss*) Well, I am afraid I am not aware, but that may be my ignorance rather than a criticism of the system.

Chairman

357. Dr Williamson, do you want to add to this?

(*Dr Williamson*) Not on the ROPA scheme because I only know of one minor award on that, but on the development of thematic programmes, I do not think the Committee should get the impression that we are against thematic programmes. I have spent a lot of my time developing thematic programmes and putting them up for assessment within the NERC system, but whereas the rules previously, as Professor Liss has mentioned, were fairly clear of what to do to succeed with thematic programmes, now it is somewhat harder and it is not just a matter of scientific excellence, but there are some problems and there is very strong competition and we do not necessarily feel that in all cases there is the right outcome and that is a matter of current discussion.

Dr Jones

358. Are there any current pressures on NERC to fund projects at the institutes at the expense perhaps of the universities?

(*Professor Liss*) I cannot comment on that because I am not close enough to the budget. Clearly there are strains in the system because it is a fixed budget system, therefore there must be a tendency to deal with problems in institutes which are NERC's first responsibility because they are employing staff and they are maintaining the institute.

359. Could that lead to them funding lower rated projects?

(*Professor Liss*) The projects in the NERC institutes are all graded and I have been part of that process. I am very happy in the part of the NERC system I see, which is the marine institutes, that the science is of a very high quality.

360. Would a higher proportion of their alpha projects be funded than the universities because they are seen as having less impact on the research councils? Is there any evidence of that?

(*Professor Liss*) I do not think so, no. The experiment is in a sense being done because now NERC has arranged its affairs in the responsive mode so in fact the institutes can bid to that pot of money and so the quality of institute science is being judged on exactly the same scale as university science. That has only been going for one grant round so it would be quite wrong to draw conclusions.

(*Dr Williamson*) The conclusion that can be drawn from the first round is that they have been particularly successful in open competition with the universities. They are rationed to the number of proposals they are allowed to submit but their success rate was proportionately higher but it is a relatively small number from one round.

(*Professor Liss*) I was not trying to draw any conclusions because I had heard on one committee at least they had not been very successful. We should not draw conclusions from a very small database.

Mr Bruce

361. I suppose by definition global climate research must be international in many ways. The existence of the IPCC and the drawing up of the Climate Agenda has created a process in which international research needs can be identified and linked to national programmes. I wonder if our two gentlemen believe that this is a process that is likely to be successful and whether indeed it has already started to be successful in co-ordinating those two international programmes?

(*Professor Liss*) That is a very big question you have asked. Maybe I could make some comments and Dr Williamson may want to add some more comments which may or may not constitute an

[**Mr Bruce** *Cont*]

answer to it. I have mentioned three global change research programmes which are in different stages of development. The World Climate Research Programme is something like 15 years old and really quite mature in these terms. The IGBP is ten years old and therefore is quite mature but not as mature as WCRP. The International Human Dimensions Programme has really had several false starts and now sponsorship has been changed and ICSU, the International Council of Scientific Unions, is a half sponsor with the International Social Science Council and it is, in a sense, starting afresh so it is ground at zero at the moment. That is the situation with respect to those. If you turn to IPCC, which is another item we mentioned, then of course the scientists in those programmes are in general the scientists who contribute to the IPCC process. I did an analysis. The IPCC Working Group 1, which is the one Sir John Houghton chairs (and you have seen him earlier), IGBP scientists in our directory contributed 33 per cent of the lead authorship in that particular working group report for the IPCC. So the international research programmes contribute to the IPCC which is an inter-governmental project, if you like, whereas the research programmes are in general more distant from the government. Central funds at least come from the academies, if I can make that rather crude distinction. It is not absolute and perhaps we do not need to go into the detail. As to the Climate Agenda that is an attempt on the climate side of the business to try and put all the different elements in a logical progression or logical arrangement and that process is on-going. The document is there but what happens next in a sense is not determined. I think there was concern amongst the governments that until that process was done and the Climate Agenda was written and you could see it and there was some logic to it they did not want to move forward and put additional funds into that area of science over and above what they were doing at that particular time. I do not know if that really answers your question. Maybe I could turn to Dr Williamson to deal with some other matters.

(*Dr Williamson*) Whether it relates to how United Kingdom national research fits along these steps and along this process and if the question is how does the individual scientist contribute to the IPCC at the end of the day, clearly through NERC funding, or whatever, they can be involved in an individual study but nationally some of the work is collected together and programmed. Within the UK there is not a very great emphasis in saying we are doing this work because it is part of the international programme. It happens to fall out that way generally that there is strong UK input in most but not all areas. In some countries there is much more coercive work saying you will only get funding if you are part of an international programme. Within the United Kingdom I do not think there is any particular advantage in any grant proposal to say this is part of something larger. It may or may not carry very much weight. It is certainly not seen as being of particular importance at an individual level.

Mr Thompson

362. There is in the United Kingdom a great deal of global environmental research expertise, not least at the university of East Anglia. Do you believe that the United Kingdom is conducting an appropriate amount of high quality research into global environmental change at present?

(*Professor Liss*) Yes, I think the Inter-Agency report, which I think Professor Hoskins spoke to you about, does try to analyse some of the numbers. It is very hard to compare numbers between countries because things are budgeted in different ways but as far as we can tell the UK seems up until the present at least putting in the sort of funds that other countries are pro-rated to GNP or some other measure of a country's ability to pursue science in their other activities. The global sum is probably not too far wrong. I think the concern that I have with it really links with the question Mr Batiste asked about the thematic programmes that the research councils are now pursuing because I think it is more difficult to justify global research in White Paper terms than to justify some other sorts of research which are based in the United Kingdom and more concerned with UK problems nearer the UK markets and its export markets. That is the concern that I have that in the past NERC has won considerable sums of money from the PES rounds for participation in international global change science. I can give you lots of examples of that, lots of successful science has been done. In a sense we have put ourselves in a forefront position but because of the constraints of the new bidding process through thematic bids and the presumed requirements of the White Paper, that is in some sort of jeopardy.

363. My understanding from your answer is that you do have some concerns about the future continuity of this?

(*Professor Liss*) Yes and I think it is a stated policy of the research councils to put less of its funds into global research than formally. I have heard the Chief Executive say that in public.

Dr Jones

364. Why did he say that was the policy? Because of the influence of the White Paper?

(*Professor Liss*) Exactly so. I think he is under constraints and pressures from the system he works under.

Dr Bray

365. Professor Liss, I think you were involved in the consideration of the 1990 report of the Inter-Governmental Panel on Climate Change which was considered by the Inter-Agency Committee on Global Environmental Change, which committee is composed of the august but not the expert. It did in fact set up a number of groups or committees to advise on what should be done. Were you involved in one of those?

(*Professor Liss*) Yes, the 1990 stage of the Inter-Agency Committee, or the equivalent then, did set up a number of working groups. I chaired one on bio-geochemical cycling, yes.

366. What action was taken on the advice of the group that you chaired?

[Dr Bray *Cont*]

(*Professor Liss*) The group I chaired came up with some interesting research objectives and some research ideas and they were followed through by the research council and particularly the NERC. We have funds flowing now which I suppose one could trace back to those sorts of endeavours. It is hard to say a committee managed to get money from a government ministry but I think one could probably say it helped.

367. It has helped and it is reassuring to hear that but have the objectives that led you to make those recommendations been fulfilled?

(*Professor Liss*) Scientists seldom claim that everything has been done and all the problems have been solved but we have certainly done some very useful work. We have advanced, yes.

368. So on the whole you would say that the way in which the 1990 follow-up worked out was satisfactory?

(*Professor Liss*) Yes.

369. Are you equally confident about the way in which the 1995 report has been followed up?

(*Professor Liss*) I have to say I am not because as far as I am aware the Inter-Agency Committee on Global Environmental Change does not exist any more.

370. It ceased to meet.

(*Professor Liss*) Well, I do not know if it ceased to meet. The best knowledge I have is that it has been wound up.

Dr Jones: The OST said that they were looking at its past performance and a possible future role and structure for a successor body.

Mrs Campbell

371. I am concerned about the national expenditure on climate research and it is quite difficult to get exact figures because of the joint research projects and so on. I just wonder if you think that that is a serious problem. Should we be able to get more accurate figures and, if so, what should be included?

(*Professor Liss*) Maybe I will toss the question to Dr Williamson because in the corridor we were talking about that very issue because this morning I got in the mail the US Global Change Programme where they publish year-by-year their programme. In the back they have all the budgets for all the different agencies and you add it all up and you find that it is £1 billion that they spend on global change research. We were talking about whether we could produce a similar histogram in the UK and I think Dr Williamson can probably answer that better than I can.

(*Dr Williamson*) The exercise that was referred to is the National Strategy Report, Professor Hoskins' document, and that did include estimates that were provided by agencies and government departments on their expenditure. The problem was that until the National Strategy Report actually got to grips with the problem, there was not a consistent definition of what was global change research, so it was interpreted in different ways and we were trying to press some of the agencies to say on what basis they had included those figures. It is true that for NERC, almost all NERC work in some way or another might come under the category and they made their estimate and it is around 30 per cent, but if one wants to include all of palaeoclimate and historical work, then there is an awful lot more and one can go further back in time and if one wants to include all possible interactions, then again there is no limit on what can be included. We tried to focus within the National Strategy Report, for which I had a secretarial role, and to try and identify something which was a little bit more consistent, but we were not able to test out that definition with the departments that were providing the financial information, so there is some room for error on this, but we were also aware that a lot of the information was going to be used for international comparisons and that there is not an internationally agreed definition and, therefore, that perhaps one can spend too long on trying to pin something down where it is very difficult to do so. However, if NERC wishes to say that it spends too much on global environment research, it can change the definition and it can spend less or it can spend more just by a stroke of the pen quite easily.

372. So I conclude that you are saying that it is not very important to have the figures because they are fairly meaningless if we have them?

(*Professor Liss*) Can I just comment, Mr Chairman, on that? As well as the UK trying to do this activity of assessing the budgets, et cetera, and deciding whether they are appropriate or not, and that is presumably the point of the exercise, to try to see if you can save some money or whether you need to spend some money, that is being done internationally as well, by a group called the International Group of Funding Agencies for Global Change Research, on which the NERC represents the UK. As you can imagine, it is much harder to do internationally because the funding of science is done differently in different countries, but they are trying in a sense to answer exactly the same question.

(*Dr Williamson*) One aspect of interest is how much of the work is very much focused on a global change problem where the work would not be carried out if we did not have the appreciation that we have achieved in the last five or ten years, so does this work contribute to one of the international programmes, the World Climate Research Programme or the International Geosphere-Biosphere Programme, and that then produces a very much smaller, more focused core programme.

(*Professor Liss*) Perhaps I could comment on that. That was the point I was going to maybe raise, but did not. The IGFA, the International Group of Funding Agencies, exercise which they did two or three years ago now concluded that the amount of money in total available for global change research internationally was just about what the programmes, the IGBP, the WCRP, et cetera, said was needed. The point was that much of the money, about 80 per cent, was not designated for supporting research in those areas, but it was for much more local research or whatever, but the Government still classified it as being global change research. So in a sense you could say that there is enough money, but its distribution is maybe inappropriate if you are wanting to support global change research. No doubt that money is being used for good purposes, but the outcome was

[**Mrs Campbell** *Cont*]
that there is actually enough money with the label of "global change research" attached to it to meet the needs of the global programmes.

Sir Gerard Vaughan

373. On the theme of the state of UK research and UK establishments, may I ask you about the *New Scientist* analysis of the recent assessment exercise which puts biochemistry way up at the top and environmental science way down at the very bottom?

(*Professor Liss*) Yes, well, I thought someone might ask about that. It is a very interesting analysis and I have to declare that I was a member of the Earth and Environmental Science's Panel, so I can tell you something, but not everything that went on in the Panel because much of it of course is not for public display. I think the analysis that the *New Scientist* did was that they took all the five and five-star departments and ratioed them to the total departments for each of the subject areas of science and biochemistry came out by far the top and environmental sciences was right at the bottom. Now, it is interesting because the Panel that I was on is Earth and Environmental Sciences and if you look at geology or earth sciences, which is the other half of the Panel, it falls somewhere in the middle of the league table, if that is what you want to call it, of five plus five-star departments. So the Panel produced a very different result for earth sciences than the one which came for environmental sciences and the reason is very clear; the Panel used the national criteria, and the Biochemistry Panel used the national criteria for that matter, and all the panels worked to exactly the same criteria for deciding five and five-star, one, two whatever it is, they all used the same, and I think that standard was well maintained. Within our Panel it was quite clear that geology is a classical, traditional subject, it has a very normal distribution of departments with the mean at about 3A, I would suspect, although I have not done the analysis, but there is a small tail of poor departments and a small upper part of very good departments, but a lot in the middle. Environmental science distribution is completely different. It has a few very good departments, including my own, and Reading Meteorology, for instance, but it has a large tail of departments which are of poor quality. I think that it is because some universities have regarded environmental science as some sort of place where they can put into the assessment departments which they do not think will rate very well in more traditional subject areas, like chemistry and biology.

374. If I can just pursue this, that is your explanation really of the figures which we have had here that 22 departments did not come up to a sort of basic national requirement.

(*Professor Liss*) I am afraid so.

Dr Bray

375. Are you saying that the environmental science departments are used as a sort of waste paper basket into which the poor-performing departments were put?

(*Professor Liss*) You are putting words into my mouth, but I would not disagree with them. I am afraid it was used—at least that is my interpretation—we have had quite a lot of submissions which were of very poor quality and sometimes you wondered, "Why are these submissions coming to environmental science?" The work being done was quite a long way from anything which you or I would regard as environmental science and it is more like biology or chemistry.

Mr Thompson

376. I am very interested in this. Are you saying that environmental sciences at the bottom end are overlapping, if you like, with what some of us would regard as the soft sciences, like social sciences or even worse things like media studies and that kind of thing?

(*Professor Liss*) No, I do not think so. I think in a sense the dilution I am talking about is because we received submissions from poor groups in chemistry and poor groups in biology, not that we have received them from media studies and other soft sciences.

377. Well, that was a bad example, but you understand what I meant by the question?

(*Professor Liss*) Yes, but I think the dilution is a different sort of dilution from the one you were talking about.

Dr Williams

378. If you had done the same kind of exercise in Germany or the United States, would you have arrived at the same kind of results in that environmental science has only just developed in the 1970s and 1980s and it has not got the structures and disciplines of traditional physics, chemistry and all the other sciences and in being a relatively new subject with a lot of new universities, smaller, those that do not have the reputation of research, you would find that internationally as well, would you? The same could be true in Germany and in the United States because if the opposite is true, then the results would be the same and if we found that the quality of our environmental science does not stand up internationally, whereas that of Germany and the United States does, then I think we would face a serious problem.

(*Professor Liss*) I do not want you to go away with the impression that we in this country are not good at environmental science. We have some really top-notch departments and I tried to show that 5* or 5 or 4 in the environmental or earth science panel was worth exactly the same as in the biochemistry or chemistry or biology panel. The standard is a national standard and an internationally pegged standard. What I think is that some universities have decided that this is an easy place to put departments which they themselves think are not very strong. That is the only conclusion I could draw from that. If you did the exercise in America or Germany I am not quite sure what the outcome would be because I do not know the departments well enough. Certainly in Germany and America they have some departments of environmental science of high

[**Dr Williams** *Cont*]

quality. Those are the ones we know of course because they have an international reputation. We would not know the ones that do not have an international reputation almost by definition. It is a difficult question to answer but I have the impression that we in this country have established environmental science departments rather more readily than they have in Germany. We recruit students in my department from Europe and you ask, "Why didn't you go to university in Germany?" and they will say, "We have so few departments of environmental science in Germany that it is almost impossible to get in." I think in Germany they have only one department of environmental science so they see our range of departments as giving more opportunity.

379. If you look at qualifications at entry, number of points, number of A-levels or E grade to E grade, how do the qualifications at entry for environmental science compare with chemistry and biology and more traditional sciences? Are we taking in weaker students? I know we are looking at research primarily but is there a filter through?

(*Professor Liss*) Of course, that depends very much on which department you are talking about. In my own department we do have higher entry qualifications than for physics or chemistry. You could probably reverse that situation in some other places.

Mr Batiste

380. I wonder if I could test your dustbin thesis for a moment and put to you an alternative view which is that nowadays universities tend to attract funds by attracting students and therefore they constantly tend to repackage, particularly the new universities, their departments in ways that they perceive to be user-friendly to potential students to attract them and the whole area of environmental science is something that captures the imagination of the young and therefore a number of universities felt the necessity to establish those departments even though they did not have anything very much to put in it. It is really a piece of advertising and packaging rather than of substance? Would that be a not unrealistic view of the way it has worked? It would fit your pattern of a few very good departments and a very long tail.

(*Professor Liss*) I do not know enough about all the courses in environmental science to say that it is true but I think it is significant that some of those courses are taught by people who have little or no research reputation. If you think it is important in a teacher that they should be a researcher or at least a significant scholar I think some of the departments are short of people like that. I have been talking about the research exercise. You could have an under-graduate programme of environmental sciences and you do not necessarily have to submit those faculty members to environmental sciences for the research assessments. If they are really chemists or biologists you could submit them to those panels.

381. The suspicion would be that in many of those universities if your environmental science department was composed of people who had not got very much in the way of research experience they would be people who were unbundled from other departments and bundled into this one in order to put forward something on a modular basis that looks quite attractive. Would the logic from that be that we have far too many environmental science departments in our universities?

(*Professor Liss*) If they are attracting students I guess the answer to that is no, we do not have too many because if the students wish to study that subject the system is such that we provide the education for them.

Sir Gerard Vaughan

382. The students may come in because they think it is an attractive subject. It is quite different if they come into a department and then find the quality of teaching is not adequate.

(*Professor Liss*) It depends what they would go and study if they did not come and study environmental science, I suppose. In a sense I am keen for science education to be more widespread in this country. If environmental science is a way of convincing more 16-18 year olds they should stick with science that is a good thing. If it means they go and study some other subjects that I will not mention here that seems to be a total loss to science.

Dr Bray

383. Which are the four good departments of international standing?

(*Professor Liss*) I can tell you because this is public knowledge and I am not telling you anything that is not available to anyone who wishes to look. The 5* departments of environmental science are the Department of Meteorology at the University of Reading, the School of Environmental Science at the University of East Anglia. The departments graded 5 are the University of Lancaster Environmental Sciences Department and the University of Southampton Department of Oceanography which is part of the Southampton Oceanography Centre.

384. How many of those recruit at under-graduate level?

(*Professor Liss*) Southampton certainly does, Lancaster does, UEA and Reading, they all do.

385. It is established as an under-graduate discipline?

(*Professor Liss*) Remember that the Reading Meteorology Department has an under-graduate programme in meteorology. They do not claim to be environmental sciences. Lancaster is environmental sciences as is UEA. Southampton is oceanography although I think they do run an environmental science programme jointly with other departments within the university, but they do not have a department of environmental science as such.

Dr Jones

386. What about groups in other departments, say in chemistry departments, are there world class departments doing environmental science?

(*Professor Liss*) Yes, there certainly are. There are some geology departments which have excellent groups doing environmental science work. That is not surprising but geology departments are often concerned with the far past, if you like the past history, but they often do have groups within them which are doing modern day work which you and I would recognise as environmental science. In applied maths departments there are often groups doing modelling of atmospheres and oceans but not in departments that call themselves that; they are called applied maths. At UEA we have significant groups in applied maths.

Sir Gerard Vaughan

387. Of course, I know about Reading very well, it is where I represent, but you have covered the ground very clearly. You have given pros and cons for low level departments. For advice to the Committee do you think we should take this very seriously into consideration, that the standards are rather low in some parts of the country, or not?

(*Professor Liss*) It is difficult for me not having done an analysis of all these departments other than at a research level to say that they have poor teaching. I said it may follow because they do not have people with research records and therefore you may deduce that the teaching must be rather derivative, if I can put it that way. I think it would be hard for me to say that you should close departments because I would have to do a rather more detailed analysis than I have been able to do or even been asked to do.

388. I do not think I was asking you to say that. Do you think that is something we should be concerned about?

(*Professor Liss*) I think it is something the universities should be concerned about certainly. If they are submitting to a panel which consistently grades them poorly they should consider whether it is the correct panel to be submitting to.

Mr Bruce

389. Can I declare an interest with a daughter who is currently studying at Reading University. I am very glad to hear that you think it has a high standard even if as a parent paying for it I have some other views sometimes! Can I talk about the effectiveness of the organisation of all of this. You have already told us you are a bit worried about how we are going. I live at the seaside and, of course, we are very keen to hear that sunshine is going to get longer and the ice-caps are not going to melt so we get swamped. The specific question is we have been given widely divergent views of the effectiveness with which climate change research is organised in the United Kingdom. Do you think it is done effectively? Do you think NERC should have a stronger role and how important is the role of the Hadley Centre?

(*Professor Liss*) Yes, a series of questions there. I think that it is an interesting question. I have read some of the previous evidence about the Hadley Centre and what various people have said and some remarks about whether the decision was correct to place the Hadley Centre under the aegis of the Meteorological Office or whether it should not have been put under NERC's aegis. I think at the time the decision was made it was probably made correctly because atmospheric sciences in NERC were really quite small. The assumption being made was that all the meteorology, which many people consider the only part of atmospheric science—and it most certainly is not -was being done by the Met Office and, therefore, atmospheric science in the NERC was not a large element. There was no institute of atmospheric sciences in the NERC portfolio. They do support research in that aspect of course, but they have no institute, and, therefore, because the assumption was made that the Meteorological Office was looking after the necessary research in the UK context and for dynamic meteorology and climate modelling, that is probably a correct assumption, but of course for atmosphere chemistry, it is not a correct assumption. So I think when the decision to have the Hadley Centre with the Met Office was made, it was probably a correct decision because there was not an infrastructure in the NERC to handle such a rather extensive enterprise of which I think the cost is £8 million a year which is not an insubstantial sum. Whether NERC would be a better home for it had the infrastructure been available I think is a good question which one could debate and maybe at some future time when the future of the Hadley Centre is being considered, it should be debated. In a sense, you could argue that it would have given a big push to atmospheric sciences in the NERC.

Dr Jones

390. Does this mean that you have concerns for the development or perhaps the demise of atmospheric science which has only about £7 million?

(*Professor Liss*) You mean the Hadley Centre?

391. No, I mean in NERC.

(*Professor Liss*) Yes, I think there is a considerable concern about atmospheric sciences in NERC because it is really quite small because there is no institute and plainly the institutes do take a large part of the budget in other parts of the NERC area, so it is a small budget and I think there is concern about it in the science community.

392. As the Met Office is under pressure to pull out of the Blue Skies research, that could be a greater worry in the future perhaps.

(*Professor Liss*) Yes, I think that is a worry for those areas which are covered by the Met Office which are essentially dynamic meteorology and the numerical climatology, but of course atmospheric chemistry is not really covered in the Met Office. There is a very small group of people in the Met Office who deal with the chemistry of the atmosphere, so that is only covered in a serious way by the NERC.

[**Dr Jones** *Cont*]

393. I did raise this with Professor Krebs and he did not seem to think there was much of a problem, but are you satisfied that NERC is addressing this issue?

(*Professor Liss*) To some extent it is. I think it is partly a funding problem and there are funding problems all around the system, but it is also partly an organisational problem. Because there is no institute which is in a sense looking after the subject, for instance, of atmospheric chemistry in the UK context, it has to be the NERC which takes the role there and makes certain that there is a correct amount of research going on. Now, because they have no Directors of Science, or there is only one Director of Science who spans the whole Council, there is little expertise at headquarters which can deal with the integration of all the efforts which are going on in small units throughout the country, largely in higher education institutes. By their very nature these are unco-ordinated because they apply for responsive-mode money and sometimes they get it and sometimes they do not and it finishes after three years, so no one has taken that overall view of "Is the level of support and organisation of that support correct for the atmospheric sciences, particularly for those aspects like atmospheric chemistry, for which the Met Office really does not have a brief?"

Dr Bray

394. What about the terrestrial boundary for climate change? Is that adequately done?

(*Professor Liss*) Well, that is better covered because there are several NERC institutes with a strong interest in that, but they approach it from the terrestrial point of view, if you like. They are not atmospheric chemists, that is not their main interest, or the number of atmospheric chemists is very small within those institutes and that is not the emphasis within the institutes.

Mrs Campbell

395. Professor Liss, I am not sure that I really understand the different roles of the Department for the Environment, the Met Office and NERC and I suspect that individual researchers do not understand them either. Do you think that is true and do you think it would be helpful if individual researchers did understand their respective roles better?

(*Professor Liss*) Well, I do not know if it is necessary for the individual researchers to worry themselves with those organisational matters. It is better for them to get on with their research, but it ought to be transparent to those people who need to know and I think probably the relationship is very well known. I do not personally have a problem with that.

Dr Jones

396. Going back to the current demise of the Inter-Agency Committee on Global Environmental Change, do you think it will be missed and how do you think that we should co-ordinate funding for changes in climate research both in terms of the different organisations and the key researchers themselves? Certainly from what we have just been discussing about atmospheric chemistry, it would seem to be very easy for things to get sort of lost and put out on a limb and gradually lose their importance.

(*Professor Liss*) Well, one point is sort of a preface point and then I will go on to answer your question. One is that a lot of the discussion today and in other evidence has been about climate change, but of course global change is much more than just climate change. You all know about the ozone hole, but of course there are many other issues of atmospheric chemistry, such as the water cycle, the availability and quality of water which are very key issues to human society and are affected by global change and will be affected in the future by global change. So the subject area is bigger than climate change in the sense you restrict it. Now, to answer your question as to whether the Inter-Agency Committee will be missed, yes, I think it will be because it was the forum where the senior people in the responsible government departments and research councils met to try to cover some of these overlap and underlap areas. I think if it is not reformed in some way, there will be a substantial problem of co-ordination. Whether it needs to be formed in the way it was previously is maybe a third answer that I can give and that is that in the Inter-Agency Committee report, which you have, we did debate this issue quite a lot and we do recommend the skeleton of the structure which might be put in place. We say that there should be two levels of co-ordination. One should be academic where the scientists who are engaged in the work should be the major players and there should be one group or committee for each of the global change programmes, like WCRP and IGBP, and probably those should be hosted by the appropriate academic body, so the Royal Society in the case of IGBP and WCRP—

397. Can you say what these acronyms mean?

(*Professor Liss*) Well, you know what the Royal Society is, so that should act as host in the case of the International Geosphere-Biosphere Programme and the World Climate Research Programme. As to who would host the International Human Dimensions Programme, I am not quite clear, but no doubt some body could be found. The point of those groups would be for scientists to decide what should be the UK's emphasis from a scientific perspective, ie, there is a huge amount of research being done internationally and the UK clearly cannot participate in all of it and we should not try to do so. So from a scientific perspective, where should we put our money and where should we advise those who have the money to put it? We have done that in the past and we have decided to work with a certain project and not work with others and other nations have made different decisions according to their criteria, so I think that is an important role for those groups. Then I think over those three academic groupings, under the Royal Society or whatever, there should be something which is equivalent to the Inter-Agency Committee which receives the scientific input from the subsidiary bodies and maybe has as representatives the chairmen of these bodies as members, but also must contain those people who

[**Dr Jones** *Cont*]
more directly control the funds, eg the Chief Executives of Research Councils, Chief Scientific Advisers to the relevant government departments, et cetera. Because they are the people who can make it happen and if the scientists say, "We should participate in this, but not in that", and they can convince the heads of research councils about it, that will be how it will actually take place.

Sir Trevor Skeet

398. Professor, can I get from you a clear view? You have had very considerable experience on the IACGEC and you have had experience on the IGBP, and there is the other organisation, the WCRP, which is the World Climate Research Programme, and you mentioned earlier in your evidence the International Human Dimensions of Global Environmental Change Programme. It seems to me that a number of organisations have suddenly sprouted. Are you going to amalgamate these and push them together, restructure them and how can you get the best out of them?

(*Professor Liss*) Can I just speak at the international level because I have just spoken of the UK national level, so I think that question is answered for the UK? Internationally they are not new bodies. The WCRP has been around for 15 years and the IGBP has been around for ten years. Some people think that they should be closed down because they have been around for quite some time, but something new would have to take their place. There is a mood that in fact because global environmental change should not be compartmentalised into the physics, the bio and geochemistry and the social aspects, that we should actually amalgamate all these three at the international level. If I might say, I think the reason why we have not done it at this point is because the International Human Dimensions Programme has really not got up and running but, that said, the linkage between the World Climate Research Programme and the International Geosphere-Biosphere Programme is increasing all the time. We are running joint programmes now very much and more and more. In a sense that integration, that marriage, is happening from the ground level without someone on high determining it should be. As soon as the social sciences, if I can put it in these words, can get their act together internationally then the marriage will happen rather quickly.

Sir Trevor Skeet: You will begin to form partnerships internationally to get ahead on various fronts and not have too many organisations internationally. Thank you very much. Dr Bray?

Dr Bray

399. Is not the appropriate organisation dependent in part on the nature of the science? On the Climate Agenda, for example, is there not an integrative concept of the model which has in turn the backing of a vast operational meteorological organisation? There is nothing equivalent to that in IGBP.

(*Professor Liss*) Yes, I am not sure that the climate people would accept that the model is everything. A lot of them spend a lot of their time data-gathering and very important data-gathering. You asked me before whether the temperature record really said something sensible. That is an activity which is extremely important in its own right so I am not sure the WCRP and the climate agenda people would accept it is all model-driven.

400. It is not all model-driven but it is an integrated concept in this situation where there is no parallel in other areas.

(*Professor Liss*) Perhaps I can take exception to that as well because I think there are a number of models in IGBP for trying to look at the whole earth from our perspective. We have a whole programme element called GAIM, Global Analysis Interpretation and Modelling, which takes the science from the individual programme elements and tries to put it together in a global picture. Inevitably that is a model of some sort and a mathematically driven model. It is much harder to model bio/geochemical than it is physical systems because you cannot write a straightforward set of equations whereas you can actually write the equations which describe the way that physics operates in the system.

401. Is that a single system or is it a whole set of different systems?

(*Professor Liss*) It is a whole set of systems, of course, and the climate models are a whole set of systems as well which integrate them or you try to integrate them into a more complex model. You know how the models are developed. People have to have sulphate aerosols in their model to get a realistic outcome. That was not true earlier. You keep incorporating pieces. What is happening now is it is necessary in models to put in biogeochemical feedbacks. That is where the fundamental linkage between IGBP and WCRP is coming about.

402. Is there not another problem for example in the International Human Dimension Programme that operationally the really important bits are the International Monetary Fund and OECD and the main international economic relationships. If that is operating and grinding away producing the actual human interventions, an analytical system which regards all that as taboo is not going to get you from first base.

(*Professor Liss*) I cannot comment on whether you can model human systems. It is clearly much more difficult than systems which are ruled by the laws of physics, biology and chemistry which are rather more studied and very simple compared with the rules, if such exist, that govern human behaviour. That is an area I cannot claim any expertise on so I perhaps cannot take that any further.

(*Dr Williamson*) I would not claim any particular expertise in that area apart from saying that the different scenarios developed for the models either assume business as usual or that we take certain measures. We need to know how realistic those measures are in societal terms. Up until now they have not been particularly realistic and that is the weakness of the model, that it does not really identify the reactions to these changes. Whatever improvement is made in that area is very necessary and needs to come along to make sure that that is a lot better than it is at present.

[**Dr Bray** *Cont*]

403. In the Inter-Governmental Panel Report, the account of the human dimension thing was a "warts and all" exposition of what the problems are. It is difficult to find an equivalent "warts and all" treatment of what the planning of research programmes should be in that area.

(*Professor Liss*) Yes in that area. In the more physical biological areas we do have chapter 13 of the working group one report, of which I was part author. It is true that it is much more difficult to organise research in human dimensions internationally than it is in the other areas we have been talking about today. It is in part because the subject is intrinsically more difficult to study. It is also because there is little or no tradition of working on a broad canvass internationally whereas physicists for instance are very good and have been doing it for a long time, working on large problems and working internationally. The biologists and chemists are somewhere in between these two poles.

Dr Bray: One group of people who, in fact, do quite a lot internationally are the economists.

Sir Trevor Skeet: We will move on to public understanding.

Mr Batiste

404. We are coming on to a final group of questions on public understanding and it generates to a degree from this marvellous research programme you had about "Iron Brew" and coverage in the press. There are others who are going to ask you about that later so I am not going to go into that part of it. You will have experienced what we always experience, that you put out a press release and the media make of it exactly what they like and it does not bear an enormous relationship to what you thought you were putting out in the press release in the first place. The problem we face as politicians in not being scientists and not being in the specialties of the subjects we have to make decisions about is that scientists come to us in two groups. One group's evidence usually starts, "The world is going to end unless ..." and the other half start, "The world is going to end if ... " We have to try and make some sense of this. I perceive at the moment whether you are talking BSE, nuclear science, genetics, or whatever, there is a growing public reluctance to accept the word of scientists about what it is they are saying about their subject. Do you perceive that in your subject as being a gap? Do you have anything to offer to us as to how we can deal with it?

(*Professor Liss*) There may be an element of truth in that and I would attribute it to the tendency to expect scientists to not only know something about science, which is their trade but also to have opinions that are worthwhile about what should be done as a result of those scientific investigations. Maybe I could say a word about BSE which I know zero about scientifically. It seemed to me that in the BSE scare (it was a scare) there was rather too much of scientists not only saying, "This is the scientific problem", and giving their scientific opinion about the problem but actually being asked to say what should be done about it. Scientists may be very good at science but they are not necessarily very good at deciding what action should be taken in particular circumstances.

405. That is really ducking the problem, is it not, because what is required for decision making is risk evaluation and it is extra-ordinarily difficult for someone other than the scientists who have studied the subject to give a meaningful risk evaluation. I know that in relation to nuclear science in particular the public is scared stiff by the word "radioactivity" so any assessment of risk so far as newspapers are concerned is distorted, but that has crept into a lot of other areas of science. If your proposition is correct, how can we as politicians make sensible judgements if you the scientists who do the research cannot produce for us meaningful risk analyses?

(*Professor Liss*) I think scientists can, but it is probably a different group of scientists who do the risk analysis. It is not the people who study the disease itself in the case of BSE and the resultant disease.

406. So would it not be the group of scientists who would be doing the risk analysis in relation to some of the decisions about your work? Quite clearly if one were to demonstrate the world today and also in 100 years unless or if, then there would be altogether a different sets of political priorities that would establish that. Some people make those statements, but people take them largely with a pinch of salt because in the main they have been made before and they have not proved to be true, but who then? If you say it should be a different group of scientists, which group of scientists would be qualified to advise government about the risk analysis inherent in the sort of research you are doing?

(*Professor Liss*) Well, there are scientists whose job is risk analysis and they are experts in assessing different sorts of risk and putting them on a relative scale and we have seen all the analyses they come up with and it is very revealing. It does not necessarily match up to our perception, the public's perception of what is a big risk and what is a small risk. It seems to me the point I made originally was that the scientists are not necessarily good at weighing up what should be done and that requires a different talent.

407. Let me put it in a slightly different way then. You produce a piece of research and let us take the Iron Brew research which may be more widely relevant or may not be more widely relevant, in what form could that be presented to decision-makers as a basis for policy judgments? How would you see your responsibility to present that paper?

(*Professor Liss*) Well, I think we have to do research and then we have to write it up and we have to present it to ministers in the terms of, "Our best estimate is that if you add this amount of iron to the oceans, you will produce this effect on the CO_2 level in the atmosphere under certain scenarios of time, et cetera, et cetera" and I think that is what you can expect of us. I do not think you can expect us to say, "And, therefore" to the politicians or whoever making the decisions, "you should add iron to the oceans".

Mr Miller

408. But part of the problem is that just as politicians sitting in this place could happily sit around and argue that today is not Wednesday, that is equally true with sciences and thinking back to my previous existence working with geologists, one of my then colleagues working on the formation of ultra-basic rock was regarded as completely off the wall at that time and yet he was presenting to you or the predecessor bodies projects which needed evaluation. Now, how on earth are we as politicians expected to come to a rational conclusion? Of course there will be proper peer-group analysis of the research programmes, but how on earth should we come to a proper conclusion about whether those unusual projects should be supported or not?

(*Professor Liss*) There are two things you need. You need an input, if you like, so you need a strong science base so you have the actual scientists out there who know what they are talking about. Secondly, you need to take more than one opinion on a difficult issue because clearly there will be different opinions among scientists. If scientific research is at the cutting edge, then inevitably you will have some uncertainty associated with it, so you need to take more than one opinion, and in a sense you have to sit in judgment having heard the quality of the argument and try and say, "Well, I think that guy is right and that guy is wrong and we will make our decision on the basis of A rather than B".

409. You see, all Members of this Committee would agree with you and your earlier comment about the need to increase public understanding of science. What would be rather difficult is for us to follow that through and say to the public outside that that is a good reason for supporting some departments which are perceived as second-rate because it increases the volume of people with science education and at the same time we are saying to the public, "Let's spend lots of money on things which represent very much minority opinions". It is presenting us with a huge political dilemma, whoever is in power.

(*Professor Liss*) Yes, but when you talk about minority opinions, it seems to me you are talking about research projects which you do not have to decide on anyway really. It is for the research councils or whoever is providing the funding who has to do that peer review and come to a judgment.

410. It is back to you.

(*Professor Liss*) It is back to us, but I thought that was what you were querying, how you deal with the aberrant scientist who wants £1 million for a crazy idea. I think the scientific system would deal with that, but that is a very different question from the one I was trying to address from this direction.

411. Taking Spencer's example or one of his examples, if you asked for an opinion here about, let us say, nuclear power, which is very relevant to areas that you are interested in, there would be very widely different opinions across parties on that subject.

(*Professor Liss*) Yes.

412. Some of the projects in that area have been very much minority interest projects supported by minorities. How can we rationally come to the conclusion that it is a properly supported use of public money?

(*Professor Liss*) I think that reinforces the point I am trying to make to you here, that actually you want to separate it and you want to create a distance between the scientific judgment and the political decision because if I can use the example of nuclear power, I think those two have got completely intermeshed and in fact no one now knows what the science is saying and what the politics or sociology is saying because they have got all messed up. That is why we do not know the way forward, so I think you want to establish some distance between the scientific advisers and the people who have to make the really tough decision which I guess is the people around here, as to what action, if any, should be taken. *The Committee suspended from 5.41 pm to 5.49 pm for a division in the House.*

Sir Trevor Skeet: Mr Thompson?

Mr Thompson

413. A moment ago we were talking about advice for policy makers and getting back to public awareness of science, I see from my notes from the 1994 European Commission's Report on Science and Technology that they said that the general public of the United Kingdom is more aware of science and technology than any other European country except Denmark. I find that rather surprising but let us assume that that is actually correct. How much do you think that research councils and individual scientists can do to improve further the public understanding of science? As far as press coverage is concerned is there a bias in the press towards particular issues? If there is can you identify important topics which should be pressed further which the press should cover better?

(*Professor Liss*) I think your question is two part. What do individual scientists do and what about the press? There has been a reluctance, and perhaps still is, amongst individual scientists to actually talk to the press and the other news media. That is not an "in principle" problem. I think it is because they are quite scared of talking on television and radio because it is quite a difficult procedure. You have to choose your words carefully and you can say wrong things and be poorly judged by your peers. I think we have to overcome that and gradually scientists are overcoming it. In discussion with colleagues I say, "If you take public money to support your research, you are obligated to tell the public what you have done with money you have taken from them." That is a line I would take. There is a responsibility on people who take public money, they must explain what they are doing. I think we should all go on courses to make us better at communicating with the public. It is quite difficult for scientists to explain things at the level required. Even in this Committee I was picked up for too many acronyms. That is a simple rule that I must be very well aware of and a training course might ram that home. There are some actions that might be taken.

[**Mr Thompson** *Cont*]

414. What about research councils themselves rather than individual scientists?

(*Professor Liss*) Maybe the research councils for their own scientists. Dr Williamson can answer that for himself because he is one and probably knows what courses there are. They are responsible for their own employees and universities should be responsible for their faculties and universities.

415. The other part of my question was whether particular topics are over-played in the press and others under-played which we in the scientific community should be pressing more?

(*Professor Liss*) From my perspective of environmental science we get a pretty good run because the environment is seen by the press, and I guess the public, as something they are interested in. I have no complaint about environmental sciences versus some other subject. If you had a physicist in here they might feel rather differently. We have a subject we are all interested in for obvious reasons; we live in the environment and we have to live with it.

(*Dr Williamson*) As a comment on that issue, the Natural Environment Research Council does put increasing emphasis on researchers explaining their work to a wide audience. Starting with the grant proposal, the first page has got to be in non-technical terms and subsequently they are expected to write up their work for NERC reports or reviews for a general audience. Whether or not the general audience is actually interested in reading about science, that is a wider problem. If we do comparatively well in the UK by some assessment I am somewhat surprised because I feel that within Germany or Scandinavia there is actually a stronger interest by the citizen in scientific matters. They do not necessarily have to have things in sensational terms whereas for the United Kingdom press there is an interest in scientific issues but there is far more interest if they can make a horror story out of it or drive it to extremes. For a scientist giving a story they will give it with the qualifications and "maybes" and "buts" but when it comes to the press report, as politicians, you know about misquotes and the way the information is used. Scientists are very sensitive, "That is not quite what I said because I then said something else. It is only the first part which was reported." Scientists can be over-cautious in trying to get it right but I think the current generation is much more concerned and does genuinely try to get the information across.

Sir Trevor Skeet: Professor, you are about to be rewarded; we are reaching our final question. Dr Bray has a point on this question.

Dr Bray

416. It is on the previous question. In asking you about public understanding, do you have any specific point on political understanding because the consequences of what you do have to be handled by the politicians?

(*Professor Liss*) I was pleasantly surprised reading the backgrounds to the Members of this Committee to find how many of them do have a scientific background.

Dr Jones

417. We are not exactly representative.

(*Professor Liss*) Well, my general impression was that politicians in general are not scientifically trained, so I do not have a particular recommendation other than that maybe more scientists should become politicians.

Mr Thompson

418. It is simply that the press do not report that there are scientists among us, I am afraid.

(*Dr Williamson*) But it is an unusual career development, to be a scientist and then to transfer to politics perhaps.

Sir Trevor Skeet: You find many rare things in politics and you find them in this Committee too!

Dr Jones

419. Mr Batiste mentioned your work which culminated in a press release which was released under the auspices of NERC and which I note actually posed the question, "Could future greenhouse warming be prevented by adding iron to under-productive oceans?" I want to ask you whether you are happy with the coverage of this work in the press and whether there were any aspects which gave you concern, but turning back to what you were saying about scientists being the ones who should interpret what should be done about their results, the fact is that in this press release you are actually inviting questions in that vein, are you not? I do not know this press release came to be developed and what input the scientists had, but clearly that is a role that NERC is expecting the press to come back to you with and yet you are saying that it is not a role that you are able to fulfil.

(*Professor Liss*) Well, can I answer briefly and then I will pass it to Dr Williamson because I have to admit that he was largely responsible, I think, for generating the press release, so maybe he would be best able to answer. I think that that was put in there because NERC realised that this would be a question which the press would raise and they were just in a sense putting it forward rather than the press coming forward and raising it themselves and not having any sort of answer in the press release. To go back to another question or statement that you made as to whether we were happy with the coverage, I think the press coverage was really quite good really because the press release was there and if you look at the items in the press, they are largely culled almost verbatim from what had been written in the NERC press release and I think that shows that you have to be well prepared with a press release if you do have an interesting scientific story. If you expect the press to understand it verbatim when you have spoken on the telephone, you will certainly find that the reporting will get it wrong, but with a press release which is well honed, and we all signed up to this press release and we all saw it and we were happy with what it said, I think at least the facts are got straight. The headlines of course are not controlled by the press release, but they are controlled by sub-editors and you will see a

[Dr Jones *Cont*]
vast range of headlines which are not necessarily ones which we would be happy with, but we have no control over that obviously.

(*Dr Williamson*) My comment on this is that putting the question in the press release is legitimate and it does not say, "and this is what you have got to do", but in fact it then answers that question within the press release by saying, "Well, actually it is not such a good idea after all because we do not think it is going to fully work and there are all sorts of other problems which come about", but when it becomes reported, it is, "This is the way to save the world", but that is someone else's assessment. We enjoy the discussion of the issue, but in reporting it, it either seems to go one way or the other and it is very difficult within the report to have both aspects properly considered, but that is not a problem that is unique to scientists.

420. But do you not really have to address this issue and you do have to be able to give an answer on the reasons or the consequences of your research and although you say scientists are not very well qualified to do this, maybe the scientists themselves need to develop mechanisms so that they can perhaps by doing some kind of networking amongst themselves and that NERC itself should have a bit more to say on the matter so that we do not have articles like the one in the *Telegraph* saying that this was the solution to global warming.

(*Professor Liss*) I think whatever NERC said, you would have got some press coverage which said, "This is the answer" because it is a tantalising possibility, if you like, but the press release was quite clear that "Professor Watson warned that any idea of such a technological 'fix' was not an easy and instant answer to global warming". That is, in a sense, our scientific assessment of the situation from the evidence we have at present. You have to remember that it is very early days yet and this experiment has been done twice in one area of ocean. The first time we got almost a zero draw-down of carbon dioxide and the second time we got a substantial draw-down. That tells you immediately that the system is either extremely variable or we do not understand it very well and probably both.

421. You did not give much emphasis to the first experiment in the press, did you? Maybe if you had—

(*Dr Williamson*) The results of the first experiment were published two years previously and this press release is covering the second experiment.

Dr Williams

422. I browsed through the notes first and then I read them in detail. When I browsed through the press release and news article I thought this must be a hoax. Global warming, perhaps the most complex problem we have ever come across, with increased iron in the ocean and you have solved it and you get a huge headline in the *Daily Telegraph* that all green people are eco-terrorists for ever showing any doubt. When I re-read it in detail, it is just one experiment on what is indeed a very complex problem. I cannot even understand why the iron, if it was animals then animals need iron but plant life generally is magnesium-based rather than iron-based although I understand they need may a small amount of iron. Is this really sound science and is there any other evidence of this kind of literature that led you carry out this experiment?

(*Professor Liss*) Yes, of course. First of all, there are large areas of the oceans where the plankton production, the plant production, is less than you would expect from the available plant nutrients, the nitrate and phosphate, the traditional nutrients of plants, and this was known in the 1930s. Even then scientists were suggesting that maybe because these areas of low production were remote from land that it was the lack of iron which was producing the under production, if I can call it that, because the main source of iron in the oceans comes from the atmosphere. It is land dust which is blown by wind and deposits on the oceans. Clearly, the further you are from land the less iron input there is into the surface oceans. So the idea was around in the 1930s but there was not an experimental measurement technique that was sophisticated enough because the levels of iron were low. It was not until recently that people were able to measure iron with sufficient accuracy. It was tested at sea using flasks where you take some sea water, that is the control, you take some of the same sea water and you add some iron and see whether a small pinch of iron—we are talking about a nanomole per litre level of iron and you see whether the flasks which have the iron in produce more plankton growth than those that do not and, lo and behold, you get substantial increased growth. Unfortunately, on some occasions you find the control also shows increased growth and the reason for that is not very clear although it is thought to be contamination. It is very hard to keep the system clean on board a research vessel which is an iron hull anyway so the results on studies done in the laboratory on the ship were not very convincing. That was the reason for the experiment where we actually added iron directly to a small patch of ocean and the results you see in the press release and the related papers etcetera.

Dr Bray

423. Would you have done the experiment if you did not think there might be a result that was interesting from a greenhouse point of view?

(*Professor Liss*) I think probably the experiment would have been done anyway because people are very interested in what controls plant production in the oceans irrespective of whether that draws down CO_2 or not because that is the basic food chain and so it has implications right up to fisheries. There are other implications than whether it can draw down CO_2.

Dr Williams

424. Can I come back and presume that the result is genuine and can be multiplied by a million-fold and presume that that is the answer, as it were. In writing up this experiment the press release is up beat. We have only got the *Daily Telegraph*'s article. If I can ask Dr Williamson here, what was your immediate feeling about the *Daily Telegraph*, since that is the only one we have here?

[**Dr Williams** *Cont*]

(*Dr Williamson*) For that one it was one of frustration that the individual concerned (this is the Matt Ridley report in the *Daily Telegraph*) had seen the *Nature* paper, he had also seen the *New Scientist* review and it was clear that that was his information source but he had not discussed the matter with the scientific group. Following a press release, normally the press tend to come back to the scientist and say, "Now explain in terms that we can understand". So it is with some frustration that there was not any discussion with him. Perhaps he would not have been able to write the same story, but it would have cleared up some of the problems (for example there is a factual error in there which he has picked up from somewhere else). We prefer it if the reporters do speak to the scientists and try and get a more balanced view of things. Seeing that report, we think, "Oh well, he has got the wrong message, but that is unfortunate".

425. I think this ties in with what Spencer opened the question with, that in this area covering understanding, we were somewhere between politicians and scientists and we quoted as one example the BSE problem and plenty of other development issues. It is one thing to have what the scientists are saying actually reported and in your specialist periodicals they are absolutely your words, but unfortunately the newspapers that we have do not carry your words and they do not carry my words even and a spin is put on everything which is in the mind of the reporter, the journalist and our words then get very badly distorted. If I can go back to comment on the BSE problem, no scientist ever said that beef was 100 per cent perfectly safe and that the word "inconceivable" was actually used by the Minister of Health and not by scientists, so generally what I ask you, as scientists, is to speak up more on the political issues. I think our real problem here when it comes to misunderstandings in science, as hugely evidenced by this matter, is that the fault really is more journalistic and the politicians' fault rather than that of the scientists themselves.

(*Professor Liss*) Clearly the Matt Ridley article understands the science to a considerable degree and gets the science right to some degree, but it is trying to use it to, in this case, knock the greens and I think that is bound to happen. If you have a free press, you get people in it pushing all sorts of ideas and I do not know that we can have any effect on that.

Dr Jones

426. Was there any rebuttal to that? Did anybody write to say that this was not fair?

(*Professor Liss*) No, but we have written to, or at least one of our colleagues has written to, I think, the Jonathan Porritt article which appeared in one of the Sunday newspapers which spoke about the "nutty professors" and that has been responded to directly to the author, not to the newspaper.

Sir Trevor Skeet: Well, that concludes the questions. We are most grateful to you for having listened to a sustained barrage of questions and for your excellent answers. We will consider every word you have said and we will take them into account. Thank you very much.

Memorandum submitted by Professor Peter Liss and Dr Phillip Williamson (23.1.97)

RESEARCH EXPENDITURE ASSESSMENTS

Information on national and international research expenditure for particular subject areas makes it potentially possible to say whether such effort is increasing or decreasing, whether it is considered to be proportionate to the problem, and whether the UK effort is comparable to that of other countries. The Committee should be aware that the expenditure estimates that are available mostly relate to global environmental research (GER) or global change research rather than just climate research. Does the Committee consider all these terms to be synonymous, or has it developed its own definitions?

Extreme accuracy in such matters is not required: figures that are "correct" to 5-10 per cent would suffice. However, category changes and other inconsistencies currently limit reliability to the range 20 - 50 per cent, and further attention to this problem is therefore justified.

1. EFFORT AT THE NATIONAL LEVEL

As discussed on 15 January, the IACGEC Expert Panel Report includes 1995–96 GER expenditure estimates, as submitted by Research Councils, Government Departments and Agencies (Table 3). However, the Expert Panel was unable to obtain the additional information to enable it to carry out a more rigorous relevance assessment. For that reason, it gave guidance on the scope of GER (Box 1), and recommended that "Funding agencies should indicate how they define GER when providing expenditure estimates. Existing national and international data should be interpreted with caution". The Expert Panel also considered that, within the GER total, it was necessary to distinguish between work that also served other purposes (underpinning research, mostly single-discipline studies) and that which was specifically directed at global change problems (interactive and systemic research, mostly multidisciplinary). Both need to be supported (Rec 6)—and a body such as IACGEC ought to assess whether the appropriate balance is being achieved.

2. EFFORT AT THE INTERNATIONAL LEVEL

Several countries publish information on their global change research expenditure. The US Report "Our Changing Planet" (an annual supplement to the President's Budget) is the most detailed: in that NASA expenditure dominates (more than 70 per cent). An attempt to increase the comparability of different national data is an ongoing task of the International Group of Funding Agencies for Global Change Research (IGFA), with UK representation via NERC and the IACGEC's UK GER Office. IGFA gives particular attention to the funding required by, and provided to, the three global change research programmes that are internationally recognised as the "key players" (World Climate Research Programme, WCRP; International Geosphere-Biosphere Programme, IGBP; and International Human Dimensions Programme on Global Environmental Change, IHDP). Documentation is available from the UK GER Office on the procedures that are currently being used by IGFA to collect and collate internationally-consistent data.

APPENDICES TO THE MINUTES OF EVIDENCE

TAKEN BEFORE THE SCIENCE AND TECHNOLOGY COMMITTEE

Letter to the Clerk of the Committee from Professor Keith Browning FRS, Joint Centre for Mesoscale Meteorology (13.6.96)

I wish to make the following submission to the forthcoming inquiry. Specifically I would like to comment on the basic (strategic) atmospheric science research co-ordinated within NERC by its Atmospheric Science and Technology Board, and on its significance to users such as the Meteorological Office and those who use its services.

Atmospheric science research has important implications in areas identified by Technology Foresight such as weather forecasting (natural hazards and risks) and the prediction of pollution and climate change. These are areas in which progress still depends on improvements in the basic understanding and modelling of atmospheric processes. The field is ripe for advances and there is a small but World-class community of researchers within the UK universities. The Met Office is concentrating its R&D on applied research and so the maintenance of the excellence of its products in the longer term will depend on the success of the basic (strategic) research in the universities as well as on the strength of the linkages with them.

I should perhaps explain the perspective from which I make these remarks. I am a Professor of Meteorology at the University of Reading and Director of the Joint Centre for Mesoscale Meteorology which brings together teams from the University and Met Office to develop and facilitate the transfer of new ideas. I am therefore aware of the synergy between research and application in this area. Accordingly I have been promoting the idea of a network of University groups addressing problems related to atmospheric processes within the context of strong links to the Met Office and other users. I am glad to say that NERC has accepted the principle of allocating funding to a new Universities Weather Research Network (UWERN). However, the funds available are small and the overall position of research in this field remains precarious.

Letter to the Clerk of the Committee from Professor Michael McIntyre, Centre for Atmospheric Science, University of Cambridge (15 June 1996)

This responds to your Press Notice of 23 May 1996, No. 12. The Science and Technology Committee might wish to take note of the following implications of recent developments at OST and NERC. I assume that the Committee would agree with me that the survival, and the commercial success, of human societies like ours will depend on having a healthy environmental science capability—on having healthy scientific eyes and ears and on using them well, in the spirit of the White Paper "Realizing our Potential". The point is sufficiently illustrated by the chemical industries' profits from CFC substitutes. Still bigger commercial opportunities are bound to arise from future, and unforeseeable, international environmental regulations. However:

1. Present funding projections at NERC imply a steeply descending ceiling on basic environmental research. On average, at least several million pounds per year will be withdrawn from such basic research over the next three years; details are given in the Annex below. The heaviest cuts are, and will be, in the university sector.

2. The resulting devastation of basic research has already become conspicuous, through the large number of alpha-rated university research grant applications that have been drastically cut or not funded at all by NERC. For instance a major Thematic bid to support basic university research centrally relevant to understanding chemical environmental change was left completely unfunded, despite getting the highest possible international peer review rating, alpha five. Unless speedily reversed, this will destroy key expertise basic to the objectives of the White Paper.

3. Such basic and centrally relevant research, considered internationally to be of the highest quality, is the kind of research that scientifically knowledgeable industrialists want the universities to do. I myself heard this message clearly and cogently reiterated (by Mr T D Culpin of the Chemical Industry Association) at the recent meeting (20 May) between scientists and users promoted by the NERC Atmospheric Science and Technology Board.

4. Such basic research is of across-the-board interest to industry. It underpins industry's more specialised, near-market research and development activities. No individual company can take responsibility for basic research; and increasing numbers of industrialists are expressing a preference for paying for it through taxes.

5. The loss of underpinning science will be costly to the nation, as well as to particular industries. The BSE affair illustrates the principles involved. These are (a) that there are many unforeseeables (the problems being formidably complicated) and (b) that other nations will take advantage of our lack of expertise as and when they can—politically as well as commercially.

6. This letter is not a personal complaint. I personally am in the very fortunate position of being able to do ultra-cheap theoretical research, problems that can be done with small computers or a pencil and paper.

I do however regret, as the nation will come to regret, the sudden destruction of what had been a coherent university programme of basic, well-coordinated atmospheric research—and, it can safely be assumed from 1 and 2 above, the sudden destruction of first-rate university research in other areas as well—and the loss of those outstanding young scientists who could have been the nation's future eyes and ears on emergent environmental change.

7. The Committee might wish to draw the attention of OST and Parliament to the gravity of the situation, and to demand that OST and NERC recognise more fully that people are a resource, even more important than equipment especially people of outstanding intellectual ability—and a resource far slower to acquire than equipment. The problem that needs tackling most urgently is that of the so-called "frictional costs" of the Centres and Surveys, which presently leave NERC with no flexibility. I understand that the Centres and Surveys are being considered in the Prior Options Review reporting at the end of July. It is urgent that ways be found to restore flexibility, to enable NERC to preserve the sine qua non capability in basic environmental science—including the ability to *understand* and weigh up scientific advances made overseas and, through respect for our expertise, to influence international regulation.

It is rumoured that the present OST executive is privately "quite sure" that global environmental change cannot be a significant problem. The Committee might like to inquire whether there is any substance to such rumours, and if so whether such an irrational and dogmatic attitude—which is contrary to any scientifically coherent view—could account for the closing-down of basic environmental research, our eyes and ears on an uncertain future.

Annex

The table below shows projected funding, as presently understood at NERC. The first three upper-limit figures are in the public domain, taken from the OST Allocation of Science Budget 1996-97, Annex A. The lower limit (second row of figures) represents what NERC presently uses in its in-house plans, presumably in response to less visible pressures from OST. These figures are in 1996 pounds. When translated into real terms (remaining rows of figures, at 2 per cent and 3 per cent per annum respectively) this implies that NERC is looking for, on average over the next three years, savings of the order of £4 million to £6 million per year.

It must be assumed, however, that far more than £4 million to £6 million per year will be taken from basic research, because of the diversion of funding to foreseeable short-term objectives arising from a short-term view of the White Paper. This diversion of funding is happening not only at NERC but also, simultaneously, at the Department of the Environment and at the Meteorological Office. The university sector is the softest target, in accountancy terms, and will feel the cumulative impact of all this, most directly because of the "frictional costs" problem at NERC.

	1996–97	*1997–98*	*1998–99*	*1999–00*	
Upper limit (unrealistic)	164.7	162.3	167.9	167.9	£ million
Lower limit (more likely)	164.7	159	161	161	
In real terms, assuming—2 per cent inflation:					
Upper limit (unrealistic)	164.7	159	161	158	
Lower limit (more likely)	164.7	156	155	152	
In real terms, assuming—3 per cent inflation:					
Upper limit (unrealistic)	164.7	158	158	154	
Lower limit (more likely)	164.7	154	152	147	

Letter to the Clerk of the Committee from Dr Richard P Wayne, Oxford University (6.96)

I understand that your Committee is to hold an inquiry into NERC, and I would like to make some comments about NERC's involvement with the funding of basic, underpinning research for atmospheric chemistry.

There is a very urgent need to secure funding for atmospheric chemistry research in order that the research community and expertise built up over the past decade or more is not now lost. There are pressing problems in atmospheric chemistry, many of which are related to man's impact on the environment, and their solution will require an increasing effort by atmospheric scientists with adequate resources as well as their own ingenuity and insights.

It looks increasingly as though NERC must be the major player in this vital area. The disbanding of agencies such as AEA and CERL, and the tendency of government departments such as DoE to look for short-term solutions to problems rather than attempting to understand the underlying science, mean that the focus of activity in research into atmospheric chemistry lies ever more with the universities funded by the research councils. With the reorganization of the research councils and their activities, NERC took over almost all of the atmospheric science interests of the old SERC. There is thus unlikely to be support from EPSRC for activities such as development of instruments for field measurements, basic laboratory studies of chemistry and photochemistry related to the atmosphere, and fundamental research to provide improvements in modelling. The academic community therefore depends on NERC for funding, now and in the future. Many of us in this community are aware of the danger that NERC might drift back—perhaps unwittingly—towards its earlier position, and allow the emphasis of its support to be for those areas of its "traditional" interest before the reorganization.

The UK now has a very strong community of researchers in the universities who cover virtually the entire range of activities that together make up the science of atmospheric chemistry. It is no good dreaming that this community can be maintained without enthusiastic support. Nor is it any good imagining that, when some new issue in, say, atmospheric pollution arises, scientists active in some other field will be able to turn their minds and research to atmospheric chemistry at a moment's notice to find an answer. What is needed is a core group of atmospheric scientists with security in the support of their speciality and able to provide the continuity of experience that alone can enable them to respond effectively to future challenges. Already, we see ourselves less well provided for than in many other member states of the EU. It is true that the European Commission itself contributes some financial resources for our research, but it is generally at a relatively low level, and intended to foster collaborative projects for which the main funding comes from national agencies.

All the comments that I have made in the preceding paragraphs are intended to underline the importance that I attach to a programme devoted to "Underpinning Research in Atmospheric Chemistry". The idea should be to support basic science in the various components of atmospheric chemistry: measurements, laboratory studies, and modelling. New knowledge, and improved understanding of what has already emerged, is truly the only way in which we will be able to meet future challenges. As a complement to such a programme, we would hope that funding through MAS RGTAC will increasingly target projects in atmospheric chemistry despite the competition from other areas for which MAS is responsible, and that must mean that MAS will have to recognize that all aspects of atmospheric chemistry fall within its domain of interest and responsibility. It is clear that new funding for these purposes will need to be sought; for example, the transfer of funds from SERC to NERC for the programme "Laboratory Studies in Atmospheric Chemistry" (LSAC) will not cover the funding of even this one vital area, even if it were to be retained and continued for its present purpose.

I hope that these remarks may be of some assistance to your Committee in its deliberations.

Letter to the Clerk of the Committee from Professor J R Cann, FRS, Department of Earth Sciences, University of Leeds (14.6.96)

1. Thank you for the opportunity to make a submission to this inquiry. I write both as an individual and as a representative of one of the largest and best university departments of earth science in the UK.

2. The Natural Environment Research Council plays a critical role in the support of basic and strategic research in Earth Sciences in the UK. The use of the term "Environment" in its title should not mislead the Committee into thinking that its role is in the support only of the science of environmentalism of green issues. While it does support research into those areas, it is, in addtion, the only source of funding of the whole of earth sciences, including geology, geophysics and oceanography, which are sciences that underpin very large areas of UK industry. These areas include the oil and gas industries, the metallic and non-metallic mineral industries, the site investigation industry, a large sector of the water industry, including both underground supplies and contamination, and the waste disposal industry. This represents a substantial fraction of UK economic activity.

3. The links between the UK earth science research community and the industries it serves have traditionally been very strong. They provide several important examples in which apparently highly academic research has led very directly to application within industry in turn resulting in substantial benefits. Instances include the development of the plate tectonic theory, which has entirely revolutionised the search for new oil and mineral deposits, the understanding of the development of sedimentary sequences in rift basins, crucial for interpretation of oil reservoirs, and observations of actively-forming ore deposits on the ocean floor, which have given new approaches to ore genesis. All of this research has been too far from the market place for industry support directly; government funding, including substantial support from NERC in the past, has brought its results rapidly into the industrial arena.

4. The role of the Natural Environment Research Council in this is crucial, and I and my colleagues are concerned that in the last few years there has been a significant shift in NERC strategy which has downplayed the objectives of earth science in favour of softer sciences such as ecology. The proportion of NERC research funds spent on earth sciences has decreased, the difficulty of obtaining research grants has increased, and there has been scarcely any funding through the responsive mode of high-cost projects, such as those involving major instrument purchase or marine expeditions.

5. In making this shift of strategy, NERC has been redefining its role towards a more green portfolio. Scientists able to obtain funds from other research councils have been attracted to NERC, and have been

successful there. This trend would not be disturbing if earth science could move similarly in reverse, but while biologists, for example, can obtain funds from several research councils, earth scientists can only find funding from one. The impact on earth science has thus been disproportionately great.

6. I and my colleagues note with concern that, at a time when research grants are increasingly hard to get, there are areas of NERC funding in which the quality of science is not assessed as rigorously as in others. This especially applies to research funding within NERC institutes, and, among those, particularly in the British Antarctic Survey. NERC has recently opened research grant applications to scientists from institutes; we believe that institute funding should conversely be opened up for competition from scientists outside the institutes.

7. Another area of concern is in NERC management of its fleet of research ships. The UK research fleet is equivalent in NERC to major facilities such as accelerators in other parts of the science community. Instead of operating such facilities as efficiently as possible, by ensuring year-round operation, filled with the best science possible, NERC recharges ship costs on a day by day basis to individual grant holders. This has two unfortunate effects. First, the NERC responsive mode grants committees are faced with requests for very large sums of money from scientists who wish to conduct research at sea, and see that in competiton with requests for smaller sums. It is an indication of this effect that the NERC Earth Sciences grants committee has not funded any ship time for two and a half years, despite applications from scientists of the highest calibre. Second, as a result, the ships are frequently tied up alongside for periods of up to several months, thus wasting a valuable research resource. It would be much more efficient and effective to run the ships as other major national facilities are run, reviewing the total provision of shiptime over a longer period.

8. In other areas of policy, NERC has been very successful. It has maintained a sensible balance between directed and responsive more research funding, and its ROPA awards have given important new opportunities for research to those who have obtained industry funding. The points I have set out above must be seen in that context, but also deserve the most urgent attention.

Letter to the Clerk of the Committee from R F P Hardman, President of the Geological Society (18.6.96)

I am writing as President of the Geological Society, the oldest Earth Science society in the world, which with some 8000 members represents the profession of geology in the United Kingdom. It awards the qualification of Chartered Geologist and seeks to maintain the standards of the profession wherever it is practised by its members. Research is of great importance to its members since they, for the greater part, either live by it or live from the fruits of its output.

The Geological Society looks to the Natural Environment Research Council (NERC) as the main source of public funds for earth science research, surveying and mapping. NERC, through the British Geological Survey (which is directly funded by NERC) has the responsibility for monitoring all geological hazards in the British Isles such as landslips, earthquakes and coastal erosion. It is also becoming increasingly involved in environmental monitoring through studies on acquifers and water supplies and by geochemical surveying.

The universities and other research institutes have the responsibility for carrying out Earth Science research whether funded by NERC or directly or indirectly by industry.

Geology is crucial to the employment and the prosperity of this nation. Among areas covered are included:

- Fossil fuel extraction (coal, oil and gas)
- Metalliferous ore extraction
- Sand, gravel aggregates and roadstone extraction
- Limestone, cement, clay quarrying for brick manufacture
- Extraction of salts for the chemical industry.

Although some of the areas such as deep mined coals and metalliferous ore extraction are in decline the sector as a whole is buoyant and in 1995 investment in the sectors which are related to the Earth Sciences totalled over £4.5 billion. This represents over 18 per cent of total UK industrial investment. The upstream oil and gas industry is particularly significant, and oil is estimated to comprise two per cent of GDP at over £12 billion in 1995[1]. The oil and gas sector employs directly over 30,000 people offshore and is responsible for indirect jobs amounting to ten times that number. Outside oil and gas another 25,000 are directly employed. There are however, no current estimates for indirect employment in those sectors outside the upstream oil and gas industry. However, this means that in industry alone over 55,000 are directly employed with another several hundred thousand engaged in jobs which are in part dependent upon geological sciences.

The NERC was streamlined just under two years ago, a new management structure and new management team being introduced. The very difficult task of managing natural environment research has been carried out generally with a very sure hand in an open and transparent manner where objectives are clearly stated and results reported. NERC faces the very difficult task in an ever more complex world of spending research money wisely. It must target funding to both reflect the national interest and respond to public concerns in such matters as environmental monitoring and protection. To balance the claims of different groups, all of whom are competing for funds, is not easy but for the most part NERC has been successful in adjudicating between these rival forces. Where there may be some concern is that in R&D in general it is reported that the United Kingdom is spending less in GDP per cent terms at 2.19 per cent than any of France (2.48 per cent) Germany (before unification 2.8 per cent) Japan (2.7 per cent) or USA (2.7 per cent)[2]. This must be a matter for concern and needs to be addressed both by Government and Industry by increased expenditure on R&D.

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[1] Brown Book of the DTI. Chart 2.2.

CURRENT REVIEW OF THE NERC RESEARCH PORTFOLIO

In its 1996 corporate plan[3] the NERC research portfolio is laid out into four major divisions.

Box A	Environmental and natural resource issues
Box B	NERC Research to benefit industry
Box C	Research to respond to scientific challenges for the next five to 10 years
Box D	Environmental Foresight Topics.

The coverage is appropriate and comprehensive. The Geological Society is particularly pleased with the emphasis in Box C on geological processes and the attempt to forecast their future. The Society views the continuation of the British Geological Survey and the British Antarctic Survey at their present levels of effectiveness as essential if objectives in Box C are to be met. These two surveys are of world class and the work they do is not only important scientifically but is of considerable national strategic value.

Whereas the Society is pleased with the comprehensiveness of the portfolio the emphasis and priorities within the portfolio must always be a matter of concern. The Science Budget of £167.6 million in 1995–96 is divided into four areas:

Infrastructure	38 per cent
Core Strategic	24 per cent
Non-Thematic	20 per cent
Thematic	18 per cent

It is noted that the number of non-thematic curiosity driven research awards over the last three years has shown a steady decline from 252 in 1992–93 to 201 in 1994–95. This suggests that non-thematic research is being de-emphasised presumably at the expense of thematic research, although the NERC "At Work" brochure states that this budget has remained constant in real terms over the past five years. The Society sees curiosity driven research as important for the future of this country. After all, penicillin was discovered as a result of curiosity driven research and to fund in this area below the current level would raise grave concerns for our scientific future.

It is also noted that in Box B there seems to be little correlation between the level of funding and the contribution by the industry to GDP, presumably reflecting a view on national priorities and the ability of that particular industry to fund itself. Fishing for instance has been allocated nearly 10 per cent of NERC's budget against a contribution of 0.2 per cent to GDP in 1991; while the relevant figures for hydrocarbon extraction are 7.5 per cent NERC budget to 1.9 per cent GDP. This must be a matter of concern.

THE EXTENT TO WHICH ENVIRONMENTAL RESEARCH IS BEST APPROACHED ON AN INTERNATIONAL BASIS

The Society would like to make two points:

(1) Environmental research demands international co-operation to be effective. For example, monitoring natural and man-made phenomena such as earthquakes and atomic explosions requires global placement of geophones; understanding ocean circulation; and past global events require world-wide measurements and continued participation in the Ocean Drilling Programme: earth monitoring from satellites is extremely costly and can best be approached through international co-operation but is essential if the restless surface of the earth is to be accurately monitored.

(2) The United Kingdom must lead in certain of these areas if its voice is to be heard by the international scientific community. In others it must contribute if its scientists are to have access to important data. Here again prioritisation is the key. For example, with the Southampton Oceanography Centre we have a world class body the adequate funding of which should remain a national priority to continue to excel in the areas of its expertise.

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[2] OECD S&T Indicators 1995 quoted in "Policies for the next Government Science and Technology" March 1996.

[3] Natural Environment Research Council—The Corporate Plan 1996.

THE FUNDING AVAILABLE TO NERC FROM SOURCES (INCLUDING GOVERNMENT SOURCES) OTHER THAN THE SCIENCE BUDGET

Science budget funding of NERC over the past three years has increased from £141.1 million to £167.7 million in 1995–96, but the contribution from other sources (commissioned research) has only grown from £39 million to £44.5 million. The Geological Society believes that NERC should target a non-science budget contribution of ⅓ the Science Budget (or in 1995–96 approximately £55 million). The other element which is important in obtaining this ratio is a reduction in the infrastructure cost of some 38 per cent of the total spend. The reduction of expenditure and the addition of funds to the other areas of expenditure ought to be a high priority since these added funds can attract matching support from industry. It is believed that NERC's strong management team, and its emphasis on research related to wealth creation should enable this stretch target to be achieved.

THE FUNDING OF MAJOR ITEMS OF EQUIPMENT

The improvement in technology which allows high level research can only be obtained at generally high cost. We can research into more and more areas if there is access to equipment and the allied technology. It is not financially feasible for all those who wish to carry out research to be supplied with their own major items of equipment. What is needed is for the equipment to be available at a convenient centre where access is made freely available.

It should be noted (above) that the Society has been arguing for some reduction in the infrastructure budget to free up funds for research projects. If overall the programme is to be maintained, equipment needs to be made available more cheaply on a pooled basis as at present, or possibly by obtaining the required services from industry at subsidised cost.

The Geological Society[4] recognises that it is only possible in a letter of this kind to give brief answers to very important questions. It welcomes the enquiry by the Select Committee. It sees the funding of scientific research as fundamental to the future welfare of the country. Should the Committee wish to amplify their questions or any other aspect of the subject the Society would be very happy to participate.

Letter to the Clerk of the Committee from Professor David Sugden, University of Edinburgh on behalf of the Royal Geographical Society (with Institute of British Geographers) (20.6.96)

We appreciate the opportunity to comment on the role of NERC over the next five years. Physical Geography in Britain depends on NERC for its research support. There are two particular issues which are of major concern to our members.

1. BALANCE BETWEEN RESPONSIVE-MODE AND DIRECTED-MODE RESEARCH

The squeeze on responsive-mode research funds is now doing long-term damage to environmental research in the UK. The appended figures show that since 1992–93 there has been an absolute decline in the total value of the support going to standard research grants within NERC. This has occurred at a time of increasing costs. Not surprisingly the success rate of a research grant graded alpha (international science) has fallen from 58 per cent to 29 per cent in three years. The drastic effect of such a situation is that at the last Earth Sciences Research Grants meeting there was insufficient money to cover the alpha four science (the second highest category).

The damage occurs because standard research grants are the way in which the best researchers with bright new ideas can explore their own innovative ideas. An excessive squeeze has three specific effects:

1. It reduces the amount of genuinely adventurous research.
2. It makes it difficult for a new young researcher with new ideas to get launched.
3. It sends out a signal which is now driving away the best researchers.

Physical geographers in the UK now see clear evidence that these three effects are beginning to appear.

The problem is aggravated by the belief that while top class research remains unfunded, lower quality research is being funded under directed mode programmes. We can demonstrate this sensitive point by reference to referees' comments on particular projects. In my judgement as a recent member of a peer review committee some projects which were funded under a responsive mode scheme would not have survived in open competition.

Assuming that NERC's role is to promote the science base in the longer term, a question we would like to pose is the following: "What is the optimum level of support for responsive-mode research?" A case could be made that an appropriate figure should be 40 per cent–50 per cent of total NERC expenditure (rather than 20 per cent at present). Further, should it not be more than directed-mode research which accounted for 23 per cent of total expenditure in 1995–96?

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[4] Leaflet on the Geological Society

2. INTERDISCIPLINARITY

Some of the world's most presing problems occur at the interface between human affairs and the natural environment; yet the existing research councils structure is split at precisely this divide with NERC focussing on environmental matters and ESRC on social and economic issues. The result is that it is difficult to fund genuinely innovative research at the interface. Inevitably at a time of competition for resources each research council supports its core scientific areas. When confronted with two topics of equal quality, one of interest to the core of the subject area and one of somewhat peripheral interest, there is always pressure for a committee to support its core responsibilties.

We welcome NERC's recognition of the importance of work at this human/environment interface. But we would like to pose the question "What specific steps can be taken to support genuinely innovative and sophisticated work at the human-environment interface?"

The RGS-IBG is grateful for the opportunity to contribute to your inquiry. We would be delighted to provide further views and information if you wish.

OFFICIAL NERC STATISTICS: STANDARD RESEARCH GRANT ROUNDS

Financial Year	*Value of awards (£k)*	*Total value of applications*	*Percentage successful alpha-graded applications*
1992–93	13,117	48,798	58
1993–94	12,675	62,830	42
1994–95	12,349	65,910	29

Letter to the Clerk of the Committee from Dr R A Cox, Centre for Atmospheric Science, University of Cambridge (20.6.96)

I write in response to your press notice of 23 May 1996 concerning the above inquiry. I note that the Committee will be addressing four main issues. As a former programme director for atmospheric science in the now disbanded Marine and Atmospheric Science Directorate at NERC, I would like to take the opportunity of commenting on each of these, with particular reference to the atmospheric sciences.

1. THE NERC RESEARCH PORTFOLIO

NERC has expanded its research portfolio in atmospheric science (climate research, meteorology and atmospheric chemistry) since 1988, in response to growing awareness of the importance of basic scientific knowledge in these areas in order to improve forecasting, sensible regulation of air pollution and developing a predictive capability for global change. Safeguard of the future for this research in NERC turns out to be even more important today because of the steep decline in the basic research effort undertaken at the Meteorological Office and the former Government Laboratories at Harwell, Warren Springs Laboratory and CER Leatherhead. The university sector, supported by NERC, is playing an ever more important strategic role in this respect. I recommend that the Committee examine carefully whether the current arrangements in the new NERC funding model can ensure the maintenance of a healthy and productive research effort over the breadth of the atmospheric science portfolio.

2. INTERNATIONAL COLLABORATION

UK atmospheric science is highly regarded by the international community. Our advice and involvement is sought in the creation and realisation of many international projects ranging from European Community funded campaigns and networks to global projects conducted in the framework of IGBP and WCRP (International Geosphere Biosphere Programme and World Climate Research Programme). The "value added" of international collaboration is exemplified in the progress made in ozone layer research in the last few years within Europe, through the conduct of the EASOE and SESAME Arctic ozone campaigns. UK involvement in this work has only been possible because of a viable "home-based" research effort.

3. NON SCIENCE-BASE FUNDING

NERC conducts a substantial amount of commissioned research mainly, but not exclusively, from government sources through its Institutes. Since there is no dedicated institute for atmospheric science, very little non-science budget funding for atmospheric science is channelled through NERC. However many university groups receive research funds from a variety of sources. For example, at University of East Anglia, funds from BP provided the main source for establishment of the Weyborne Atmospheric Observatory, and

Department of the Environment have commissioned research on atmospheric pollution there and elsewhere. This funding is however always short term and relies on the existence of a viable baseline scientific programme.

4. FUNDING FOR EQUIPMENT

Commissioned research, including that from the EU research programmes does not provide for procurement of major items of equipment and facilities. NERC has to play a major role here. A particularly important issue at present for the atmospheric sciences in the provision of aircraft facilities for atmospheric research. I advise the committee to pay particular attention to the situation regarding the Met Research Flight C–130 aircraft, which plays a central role in NERC's field programmes and which has an uncertain future in the MoD. In contrast NERC is rather well equipped with research ships and associated infrastructure. The popular "small equipment" grants round disappeared with a funding squeeze two years ago.

I hope these comments provide some assistance to your inquiry.

Memorandum submitted by Royal Meteorological Society (20.6.96)

INTRODUCTION

1. The Natural Environment Research Council (NERC) is a key source of support for fundamental research (in both universities and NERC institutes) in a wide range of environmental sciences that provide the scientific basis for many activities of national, and international, importance. For this reason, the Council of the Royal Meteorological Society (RMS) welcomes the inquiry into NERC by the House of Commons Science and Technology Committee and, at its meeting on 19 June 1996, agreed the following submission. In brief, our main points are:

- NERC funded research underpins the applications of atmospheric science in the UK. Its influence is highly pervasive into many activities, such as weather forecasting, climate change studies, pollution studies, etc. Although the funding level is relatively small, this support is a critical element in the continuing success of UK atmospheric research;
- The quality of UK atmospheric research is of the highest order, and is competitive with the best anywhere in the world;
- The benefits to society resulting from the atmospheric sciences are deep and extensive. Important applications include weather forecasting, climate change detection and prediction, the forecasting of severe storms and other extreme events, etc;
- Planning within NERC must seek to establish a stable and adequate funding base for this important underpinning activity;
- The changing relationship between the academic community and the Met Office has to be recognised, given the latter's new status as a Trading Fund. This development increases the importance of the science base provided by NERC.

BACKGROUND

2. The Royal Meteorological Society has some 3,500 members, and is a source of considerable knowledge in its field. It is keen, therefore, to play a full role in any national discussions which relate to subjects within its ambit. In this context the Society has interest in a wide range of NERC sciences, including atmospheric science (in its widest interpretation), oceanography and hydrology. In particular, the increasingly important practical aspects of weather forecasting and climate-related issues depend for their future development and improvement on this wide range (and wider in the specific case of climate change) of NERC science. Having established this point, the remainder of our submission focuses primarily on the state of the atmospheric sciences within NERC. It is this which gives the RMS Council most concern at this juncture.

Atmospheric science is concerned with the properties and processes of the atmosphere from the surface through to the uppermost levels. This includes studies not only of fundamental dynamical, physical and chemical atmospheric phenomena, but also of the vital exchanges of energy, momentum and mass between the atmosphere and the underlying surface, be that water, soil, vegetation, ice or snow. These aim to improve our understanding of the composition, structure, evolution and processes of the atmosphere in which we live, and on whose resources we depend. Such studies provide the scientific foundation for example for weather forecasting (at all time–scales), climate simulation, the detection and predication of climate change, understanding and predicting stratospheric ozone depletion (the "ozone hole"), and air–pollution studies (at all spatial scales from local to global).

THE QUALITY OF ATMOSPHERIC SCIENCE IN THE UK

3. The quality and productivity of the atmospheric sciences in the UK, measured on any scale, are very high. This includes comparison with the best international standards, for example in the USA. The following are some examples of the high standing of UK research. In all cases, the work cited is recognised internationally as excellent:

(i) Within Europe, the UK has maintained the leading position since World War II. British scientists publish widely, are sought after for international peer review groups, science teams, etc, and are often at the forefront of research, across many of the areas identified in section 3 above.

(ii) More widely, the reputation of British atmospheric science is also very high. For example, UK scientists are highly thought of in the USA. They are frequently invited to join major scientific projects; are widely used for peer review; are invited to partake in programme reviews (eg of NASA Laboratories), and feature prominently in international Societies and symposia, especially in atmospheric chemistry, climate studies, dynamics, oceanography, radiation sensing, and the scientific basis of weather forecasting.

(iii) UK scientists play a strong role in the International Council of Scientific Unions and other international organisations. For example, last year British scientists held the Presidencies of the International Association of Meteorology and the Atmospheric Sciences, the International Radiation Commission, and the International Commission on Dynamical Meteorology. The UK has figured prominently and with great distinction in the work of the Inter-governmental Panel on Climate Change. British scientists also feature prominently in numerous European Union programmes. This level of involvement and status has been enjoyed by UK scientists for many years, and is a continuing one.

(iv) The high standards in British atmospheric science are reflected in the high reputation for quality and integrity of the publications of the Society. In particular, our Quarterly Journal enjoys a reputation for quality probably unrivalled, and certainly at least on par, for example, with the best American journals. NERC is an important contributor to these journals in funding excellent research, which is then reported in their pages.

(v) A few examples are given to indicate areas of interest, effort and investment which, if elaborated on, would underscore the quality argument:

- Development of satellite remote sensing techniques (pressure modulation, retrieval theory) at Oxford and Reading universities, and the Rutherford Appleton Laboratory (RAL);
- Crutzen's Nobel Prize work on stratospheric ozone was carried out at Oxford.
- Ozone hole discovered at British Antarctic Survey, Cambridge;
- University of East Anglia work on analysis of climate data (complementing research at the Meteorological Office's Hadley Centre);
- Pioneering and influential fundamental work on fronts, storms and globals atmospheric circulation at Reading;
- Basic research on atmospheric radiative transfer at Reading and Imperial College;
- LIDAR and Radar observations at Aberystwyth;
- Observations and theoretical studies of stratospheric chemistry and dynamics at the Centre for Atmospheric Sciences in Cambridge; Oxford; Imperial College; Edinburgh; and RAL;
- Development of novel satellite sensors at Heriot-Watt University, Oxford and RAL;
- Laboratory studies of chemical reactions and spectroscopy, at Leeds, Cambridge, Imperial College and RAL;
- New investments by NERC at Imperial College, and Leicester in Earth observaton and atmospheric science;
- The high international standing of the UK Meteorological Office's weather forecasts and other products and services;
- Siting of the European Centre for Medium Range Weather Forecasts in Reading;
- The success of the Universities Global Atmospheric Modelling Programme in developing and using a suite of advanced models of the atmosphere, at Reading, Cambridge, Edinburgh, Imperial College and elsewhere, including the highly successful exploitation of the Research Council's supercomputers for model development;
- The joint NERC-Met Office-Reading University Centre for Mesoscale Meteorology;
- Work on atmospheric electricity, clouds and aerosols at the University of Manchester Institute of Science and Technology.

Organisational and Funding Issues

4. The Society wishes to register the deep concerns that it has received from the research community about the present funding plans for NERC atmospheric science which have generated uncertainties with regard to the future of the subject. This is thought to be due to funding mechanisms rather than having any relation to a judgement based on value and quality. As already stated, the Society is of the view that the quality of work in the field is very high and, if necessary, would be very happy to assist the Inquiry further to demonstrate this. Meanwhile, the Society would wish to urge NERC, through the Inquiry, to ensure that programmes and projects are developed with continuity and stability, as well as with excellence, in mind.

5. The NERC funded programme in atmospheric science, and those of the Met Office and the DoE have in the past formed a well matched balance, between the needs of current issues (weather forecasting, climate change), and longer term interests which require an underpinning stratum of excellent basic research. The significance of the latter, in maintaining the science base, generating trained scientists, and maintaining the UK reputation internationally, cannot be stressed enough. Nevertheless, the relationship between these programmes needs to be kept under review, especially as the exigencies of Trading Fund status bite into the Met Office capability to underpin its operational role with R&D. The Society stands ready to play its full role in helping to monitor these relationships.

6. NERC must remain a major promoter and funder of global environmental research, including climate research. This remains one of the most important, difficult and challenging areas of scientific activity known to mankind, on a par with genetics research, biodiversity and cosmology as one of the "Grand Challenges". The critical importance of NERC underpinning science to applied studies of global climate change, desertification, food and water supply, etc must be recognised. It must also be recognised that NERC deserves congratulations for the many scientific advances in climate studies, and indeed throughout the atmospheric sciences, which its support has enabled in the past.

7. The NERC atmospheric science budget is small. It amounts to about £5 million per annum in a total budget of c £160 million. In other words, it represents about three per cent of the NERC budget. This is a small amount to be spending on basic underpinning research, considering the importance of the atmospheric sciences to the UK, not only in terms of weather forecasting but also in climate change, air pollution, agriculture, air transport, and so on. However, the importance of continuing this support is paramount, and it has to be said that the NERC investment in atmospheric science to date, though small, has been extremely cost-effective.

8. Even when the directed R&D programmes of the Met Office and the Department of the Environment (principally through the Hadley Centre) are taken into account, this still remains a small total national spend, considering the importance of the atmospheric sciences to our nation, and the benefits in many areas which a sound science base will ensure. An especially important point, which deserves repeating, is that the NERC contribution, representing as it does the principal source of support for university applied and basic research, should not fall below the present, already very low, level.

Memorandum submitted by Dr S A Thorpe FRS, Department of Oceanography, University of Southampton (20.6.96)

THE NATURAL ENVIRONMENT RESEARCH COUNCIL AND MARINE SCIENCE

The Mission Statement of the Research Council describes its function and purpose. It has a broad brief to support research and training in the environmental sciences, and it is my view that, in general, it achieves its mission. I shall confine my comments to Ocean Sciences.

Research Portfolio

The UK has traditionally played a major role in the study of the oceans. The cruise of HMS Challenger in the 1870s established that life exists in the very depth of the oceans. The floats designed by Dr John Swallow of the National Institute of Oceanography (later the Institute of Oceanographic Sciences) in the 1950s proved that irregular motions exist in the deep ocean and completely altered oceanographers' perceptions of ocean dynamics. British scientists led the discovery of plate tectonics in the 1960s which revised understanding of the evolution of the Earth's crust. British scientists, notably Prof M S Longuet-Higgins (sadly now working in the US), were foremost in the study of ocean waves and their research provided essential information for the development of the UK Offshore Hydrocarbon Industry. Understanding of ocean mixing, essential in the prediction of the dispersion of pollution or in the assessment of the risks involved in the disposal of wastes in the ocean, has been led by British scientists.

Little of the true value-benefit has been returned from users to sustain further research, but this is hardly surprising; the science is largely basic science and has to be done to provide a platform for later near-market application. Often applications are undreamt-of at the time the basic science was done. Rarely can the benefits of fundamental research be seen in advance. Countries have a natural interest in their territories. The UK has long coastlines and extensive sea areas, and is wise and prudent to invest in their exploration, the study of benefits, hazards and risks which they may impose, and means of management.

NERC is the leading Agency in continuing the United Kingdom's tradition of research into the oceans and of underpinning National or Government Department requirements (eg Defence-related) or Commercially-related needs by basic research. The targeting of research to present day needs (eg pollution or the ability of the oceans to receive and contain wastes) is important. Marine scientists know that, and have responded enthusiastically to these intellectual and technical challenges. The oceans are however still so poorly known that basic exploration and, in particular, routine or operational monitoring within and around UK waters, are essential if we are to use the oceans in a sustainable way, conserving what will be of value to future generations. It has been said that we know more of the backside of the moon or the surface of planet Venus than we know of the ocean floor, even in the Northeast Atlantic! Long-term monitoring has proved to be of great importance in the atmosphere (eg in the assessment of climate change). Knowledge of the oceans lags some 30 years behind that in the atmosphere, and few records extend for more than two or three decades. Prediction into the future is therefore uncertain. The Met Office does provide some marine prediction (eg of storm surges and waves) but few. There is no "Wet Office"!

NERC's portfolio should reflect these concerns.

NERC Funding and the Training of Scientists

NERC is a leading agency in funding the training of future environmental scientists. The "climate of research" which includes staff morale, is affected by NERC's research portfolio and its ability to manage its institutes and funded organisations. This, and "career structure", have an important influence on the attraction of gifted young scientists into the field of environmental science. It is not understating the point to claim that the guardianship of our "green and pleasant land" and the seas around it depends on the Nation's ability to attract high quality scientists into the study of the environment. It is NERC's role to ensure that this happens.

It is my view that teaching and training of students is best done within a research environment. This ensures that teaching includes and reflects present-day understanding, technology and methods. (I should like to see teaching at university level conducted in proximity to user bodies, in this case the marine business community, but attempts to establish a Marine Science and Technology Business Park alongside the NERC-University of Southampton "Southampton Oceanography Centre" have so far not been successful). Continuity of research funding is thus related to teaching. There is concern about the ability of NERC to support those applications for research funds which are highly-rated. Whilst this has forced marine scientists to seek funds elsewhere, often successfully, and this is no bad thing in itself, it has led to much wastage of time and effort in preparing applications for funds. Some element of a 'rolling grant' scheme might help avoid this problem.

In future there will be a need for environmental scientists with skills and training which cross traditional areas, notably for scientists with expertise in legal matters and in socio-economics. It is unlikely that sufficient skills can be derived from a "mixed course" training at undergraduate or even masters level, and there is a need to encourage and to provide the means for young people who are already well qualified (eg science graduates or those who have some experience in research in science), to train in these other disciplines.

International Basis of Research

A mix of local, national and international research is an essential part of NERC's research portfolio. International collaboration is essential in (i) conducting research where the magnitude of the task is so huge or widespread that it cannot be undertaken by any single nation (eg the World Ocean Circulation Experiment, WOCE), (ii) undertaking comparative studies, (iii) identifying markets for research, and (iv) injecting new insights, stimulating further research or challenging conventional ideas.

Major Equipment

Undertaking research in the oceans requires ships. These are major cost items. The information they obtain cannot be collected by satellites or by any other means, although the present development of robotic systems and automated submersibles (AUTOSUBS) may, within the next 50 years, provide alternative methods of collecting some of the data required to forecast and predict (or "control") the ocean and its internal climate.

NERC appears to have insufficient funds to maximise the use of existing vessels for which there is considerable research demand. The future of the UK AUTOSUBS project is in doubt.

Management

The nine year experiment conducted by NERC in appointing "Directors of Science" (Earth, Marine and Terrestrial Life Sciences), 1985–1994, gave undoubted leadership in some areas of Environmental Science. It was by no means perfect, and the continuation of staff in post beyond the original five year appointment term led to the growth of problems stemming from personalities and problems at the interface of separate disciplines. Nevertheless, it provided leadership in some areas in which it is now lacking. One is Marine Science.

Letter to the Clerk of the Committee from Dr P B Tinker (20.6.96)

Thank you for notifying me about the inquiry of your Committee into the Natural Environment Research Council. I am making comments because of my period of seven years as Director of Science for Terrestrial and Freshwater Sciences in the Council, terminating with my retirement at the end of 1992.

I wish to comment on three of your points, as they relate to the Terrestrial and Freshwater Sciences, where my experience and expertise lie. These are:

1. The NERC research portfolio at present is strong and well balanced. It has a good programme in all major areas of environmental work within the UK, as well as research and collaboration in many countries overseas. A very important aspect of this is its capacity to do multidisciplinary science, and to combine the special skills of University and Institute science.

Multidisciplinary science is always praised, but in practice many scientists tend to return to their disciplinary niche when hard choices have to be made. This type of science was strongly encouraged by me during my time at NERC, and I am pleased that the Institutes in these subjects have now been combined into the Centre for Ecology and Hydrology, in a natural progression from earlier actions. This multidisciplinary capacity has considerable value, and it would be a great pity if it were lost in further reorganisation. Multidisciplinary science should logically include collaboration between the Research Councils, but this occurs very rarely.

A further aspect of the research portfolio, particularly of the large Community Programmes launched over the last few years, has been the ability to join the skills of University and Institute scientists. The skills and the approaches of these groups do differ, even though they overlap, and an integrated approach has been very effective in operating joint sites in UK and abroad. In this case I am concerned about the effects of the recent reorganisation, in that there is now no obvious mechanism for bringing these groups together, such as previously existed in the Directorates.

2. You raise the question of the international basis of environmental science. This is less clear in the terrestrial and freshwater sciences than in the marine and astmospheric ones, simply because the terrestrial surface is very diverse, and many problems and issues are site-specific. For that reason these sciences in NERC have regarded the UK as their primary focus. However, there are many issues of general application, such as the effect of elevated carbon dioxide on managed and natural vegetation. NERC had excellent links with international programmes on global change, acid rain and conservation, but I am not clear what the policy is on this at present. The links with European programmes should be particularly strong, because of the similarity of climates, land use and socioeconomic conditions in appropriate parts, so that joint approaches to problems are obviously sensible. I suspect that UK Government departments do not always support such activity as strongly as they could.

3. I am not well informed about the exact state of non-Science Budget funding at present in NERC, but the terrestrial and freshwater scientists have shown that they can attract large amounts of contract funding. The value of their work, in terms of environmental benefits and quality of life, is obvious, and I know that they are exploiting this ability forcefully. However, I believe that there is a danger of a sharp change in the quality and skills of an Institute if it is required to raise all its income from short-term external contracts, and the shorter and more sporadic and empirical these are, the worse this effect becomes. To maintain its scientific quality and its long-term mission an Institute has to have a certain amount of dependable long-term funding with which the Director can plan ahead for new initiatives. This funding can be from the Science Budget, from long-term and profitable contracts with specific organisations, or from a general level of profitability that produces a reliable surplus. This last is difficult to achieve in enviromental science, for reasons that are well known. Unless this issue is given careful attention, the capacity for high-grade science in the NERC Institutes could easily be lost.

Memorandum submitted by D T and S L Donovan (6.96)

1. INTRODUCTION

The Committee announced on 23 May 1996 its intention to examine the Natural Environment Research Council. It intended to look at broad issues facing the Council in the next five years, including

The current review of research (ie the Prior Options Review)

The extent to which environmental research should be approached on an international basis

Funding available

Funding of major equipment.

We comment on some of these issues below.

2. THE PRIOR OPTIONS REVIEW

2.1 *History*

When the NERC was set up (Science and Technology Act 1965) it inherited from the Department of Scientific and Industrial Research a dual responsibility: of running certain PSRIs, of which the Geological Survey (now British Geological Survey) was the largest, and of awarding research grants and studentships to universities.

In the 30 years since its inception there have been major changes in both the composition and the organisation of NERC (Annex 1). This pattern of episodic change has had its effects both on PSRIs and on university research. A period of stability is highly desirable.

2.2 *Recent reviews*

The last decade has been a period of government reviews of PSRIs. The BGS, for example, has been the subject of at least five reviews[1] since 1985. While the use of public money is a legitimate concern of government, the consequence of this in recent years has been excessive meddling which is bound to have adverse effects both on staff morale and on the capability of institutes to organise their work effectively.

Eight of NERC's component institutes[2] were assessed by the Multi-Disciplinary Scrutiny of PSREs (1994). This Scrutiny having attracted universal condemnation[3], a second attempt to destabilise the institutes has been made by subjecting them to a Prior Options Review[4]. These institutes together spend 37 per cent of NERC budget[5].

We have submitted a comment to the Prior Options Review Team in which we concluded that BGS should remain in the public sector, and stated that

> We see no change in the national need for the functions presently performed by BGS, and documented in detail by Butler (§§6.4–6.11). If anything the increased emphasis on sustainable development, and on conservation of natural resources and the environment, reinforces it.
>
> With work arranged, as it has been since 1985–87, into a Core Programme and a Responsive Programme the BGS is well organised to meet the national needs identified above.
>
> It is similarly able to play a vital part in fulfilling Britain's international role in assisting developing countries, as a respected advisor and educator in many overseas areas. This is a role which cannot be satisfactorily played by private enterprise, which by its nature has short-term horizons and limited objectives.

We are not familiar in detail with the other institutes under review but we suppose that similar considerations apply to them. If any or all of these PSRIs are abolished or privatised the structure of NERC will be radically changed and its capabilities seriously reduced.

3. EXTENT TO WHICH ENVIRONMENTAL RESEARCH IS BEST APPROACHED ON AN INTERNATIONAL BASIS

Research sponsored by NERC or performed by its institutes ranges from work on geographically defined areas within the UK—eg geological mapping, work on terrestrial and freshwater flora and fauna, monitoring of groundwater pollution—to topics which are not limited by national boundaries—eg oceanography, deep sea floor studies, global climatic studies; and more abstract topics including botanical and zoological systematics.

While geographically defined work may have general implications, it is primarily of relevance for national resources and environment, and its funding and priorities must be determined on the basis of national need.

Work in the second category, by contrast, is (or should be) influenced by at least two other factors—1. Scientific: The particular expertise and experience which Britain can contribute to problems of international dimension; 2. Political: the extent to which the government wishes to be seen to be contributing to the study of world problems (eg climate change) and (hopefully) to acquire influence by intellectual rather than military or economic means.

The way the NERC accounts are currently presented to the public[6] does not enable allocation of NERC resources to be broken down by these categories.

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[1] Butler Study Group, 1985; Price Waterhouse 1990; Price Waterhouse c. 1993; Multidisciplinary Scrutiny, 1994; Prior Options Review, 1995.

[2] British Geological Survey; Dunstaffnage Marine Laboratory; Institutes of Freshwater Ecology, Hydrology, Terrestrial Ecology, and Virology & Environmental Microbiology; Plymouth Marine Laboratory; Proudman Oceanographic Laboratory.

[3] HC Paper 19–I,II, Session 1994–95; HL Paper 5–I, Session 1994–95.

[4] This is reviewing three bodies, actually the same ones scrutinised in 1994: CCMS (Centre for Coastal and Marine Science) and CEH (Centre for Ecology and Hydrology) having been formed from the institutes (apart from BGS) listed in footnote 2.

[5] NERC Report & Accounts 1994–95.

[6] eg NERC Report & Accounts for 1994–95. Appendix 3. Summary of payments by cost centre.

4. Sources of Funding

4.1 *International programmes*

Support for work of international dimension must surely be funded from the science vote. Some of the work will stem from obligations into which government has entered, literally by treaty or effectively according to its conscience; government must pay for obligations which it has taken on. Having decided to fund projects, government will wish to influence their direction at least in general terms.

International programmes in subjects such as oceanography, atmospheric science, and climate need to be long-term. Therefore they need long-term assured funding, and the staff operating them need stability and appropriate career structures. This is another reason why earmarked central government funding is essential for such programmes.

4.2 *Data centres*

A very important aspect of NERC is its responsibility for acquiring and providing environmental data through its seven Data Centres. Its Chief Executive and his officials recently expounded their policy of openly supplying this information to enquirers, generally at little or no cost in the case of non-commercial users[7]. There will be a temptation at the present time of financial stringency to privatise data centres. This would have serious adverse effects: 1. Charges could rise, inhibiting the use of information especially by non-commercial users; 2. Restrictions could be placed on the supply of information; 3. Donors of data will be reluctant to give information to a private body, with which they may be in competition.

4.3 *General*

Of particular concern is the loss of information to the public domain where research is carried out under formal contracts involving private finance. Information as to the participants, scale, nature and details of the brief for research commissioned in this way may be witheld as "commercial in confidence", as also may the results. This does not augur well for increased awareness of work which should be of public concern. Questions of both public interest and proper peer review of work in progress are here involved.

Leaders of both main opposition parties have voiced their belief in the importance of science[8] but the science budget in the near future, whatever the political hue of government, is bound to suffer intense competition. Research organisations have already been under great pressure for some years; 1. to be more efficient; and 2. to generate their own funding, and it may well be that not much more can be achieved in these directions. The outlook for even modest and desirable expansion is not encouraging.

However, governments seldom seem to appreciate the extent to which effective support of research programmes can enhance a nation's reputation at relatively small cost. In the present state of public awareness of problems such as global warming and environmental conservation, there is an excellent opportunity to exploit our expertise in fields such as oceanography, atmospheric sciences and biological sciences, and we urge the Select Committee to recommend government to provide enhanced funding in these areas.

[DTD was Yates-Goldsmid Professor and Head of Department of Geology at University College London 1966–1982. He has collaborated with BGS for many years. SLD has worked in local authorities on land use, wastes and minerals planning and site reclamation, and in the hydrocarbon exploration industry in several countries.]

Annex 1

Brief History of NERC

The NERC was set up, along with SERC, by the Science and Technology Act 1965 to take over some functions of the Department of Scientific and Industrial Research which was abolished by the same Act. It inherited from DSIR a dual responsibility: of running certain PSRIs, of which the Geological Survey (now British Geological Survey) was the largest, and of awarding research grants and studentships to universities.

A major change in NERC research institute funding occurred in 1972–73 when the "Rothschild proposals"[9] were implemented. By 1975–76 29 per cent of Science Vote money had been transferred from NERC to government departments, which were expected, but not compelled, to commission work from

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[7] HL Select Committee on the European Communities (Sub-Committee C), 24 April 1996. Transcript of evidence, questions 195–229.

[8] The late John Smith, speech to Save British Science 17.11.93; Paddy Ashdown, ditto, 24.11.94.

[9] The Organisation and Management of Government R&D. Cmnd 4814, 1971.

PSRIs which had formerly been funded directly. The major impact fell on BGS which was in serious trouble a few years later as commissions were withdrawn by departments[10].

In 1973 the Nature Conservancy was removed from NERC to become a separate council. A major internal re-organisation of NERC was inaugurated in 1985[11]. This *i.a.* created three Directors of Science to oversee the main fields of activity. These posts were abolished in 1994 as part of another "series of far-reaching changes" in the organisation[12]. Meanwhile in 1992–93 the Dual Funding Transfer had begun whereby resources formerly split between the HEFCs (previously UGC) and the Research Councils were given wholly to the councils to administer. This was "the biggest change ever to the funding of research grants"[13].

The laboratories of several bodies which had formerly been grant-aided (eg MBA, SMBA) were incorporated in NERC in the late 1980s. In 1993 the White Paper "Realising our potential" re-organised the Research Councils. NERC remained the same in name but acquired additional responsibility for earth observation, atmospheric chemistry and science-based archaeology from the former SERC. A "new funding model" within NERC is to be fully implemented in 1996–97[14].

The transfer in July 1995 of the OST to the DTI "aroused antipathy and concern in the academic community" which the Chief Executive of NERC did his best to dispel[15].

At time of inception, NERC funding was almost wholly from the Science Vote. This is now reduced to 74 per cent of total income[16]. Funding of individual institutes is not in proportion: for example, BGS income is almost 50/50 divided between Science Budget and commissioned work. Universities were to receive about 39 per cent of the Science vote allocation in 1994–95[17].

ACRONYMS

ABRC	Advisory Board for the Research Councils
BGS	British Geological Survey
CCMS	Centre for Coastal and Marine Science
CEH	Centre for Ecology and Hydrology
DSIR	Department of Scientific and Industrial Research
HEFC	Higher Education Funding Council
MBA	Marine Biological Association of the UK
NERC	Natural Environment Research Council
OST	Office of Science and Technology
PSRI	Public Sector Research Institute
SERC	Science and Engineering Research Council
SMBA	Scottish Marine Biological Association
UGC	(former) University Grants Committee

Memorandum submitted by AEA Technology Plc (25.6.96)

1. BACKGROUND/CREDENTIALS

AEA Technology plc is a major UK-based science and engineering services business with a significant international activity. It is currently in the public sector but will enter the private sector in due course.

Through its National Environmental Technology Centre, AEA Technology plc is a major supplier of environmental technology services to both Government and industry. In this role. it is both a user and supplier of environmental R&D.

AEA Technology plc is an active participate in international R&D programmes, particularly on environmental and energy issues. It is involved in both formal and informal partnerships with environmental research organisations in Europe and the rest of the world. Through practical involvement in international R&D programmes it has a good understanding of the factors that contribute towards the success or failure of such programmes.

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[10] C Butler, Report of the Study Group into Geological Surveying, ABRC/NERC 1987, para. 5.3.

[11] NERC Corporate Plan 1985–90 (Feb. 1985).

[12] NERC Annual Report & Accounts 1993–94, p. 1.

[13] Prof J L Knill in NERC Report & Accounts 1992–93, p. 1. It is curious, however, that recent reviews of research and excellence in university science departments have been carried out by HEFC, not by research councils.

[14] NERC Report & Accounts, 1994–95, p. 6.

[15] NERC Report & Accounts 1994–95, pp. 2, 3.

[16] NERC Rep & Accounts 1994–5, pp. 55, 56.

[17] NERC 1994 Corporate Plan, p. 19.

2. COMMENTS

We believe that environmental research is best carried out on an international basis where:

- the scale of the resources required (physical, human or financial) are beyond what can be supplied at national level; and
- the problems being addressed are transboundary (eg climate change, acidification), or similar in nature between different countries (eg urban air quality).

In practice, the success or failure of international programmes of environmental research is less dependent on the criteria used to select the programmes than how such programmes are implemented. Inevitably there are political compromises in selecting the partners who will be involved in international programmes. Ideally, partners should be selected on the basis of scientific/technical excellence: but as a minimun, partnerships should reflect a long-term commitment to collaborate rather than a short-term expediency to secure funding.

More fundamental weaknesses in the way international programmes of R&D are implemented are:

- low involvement of end-users
- poor dissemination of result and/or weak technology transfer.

For the reasons explained above, international R&D programmes tend to address relatively long-term strategic issues. It is always difficult to involve (potential) end-users in these programmes as the international dimension often exacerbates the problem. International programmes tend to be excessively dominated by purely scientific issues, and the needs of end-users can be neglected.

For similar reasons, dissemination and technology transfer are often given relatively low priority in international R&D programmes. Often dissemination is no more than an add-on at the end of the programme.

Greater emphasis needs to be placed on dissemination and technology transfer as essential elements of these programmes and an acceptance that if the results are not used then the programme has been of limited success—whatever its purely scientific achievements.

We believe that science and engineering organisations such as AEA Technology plc have an important role to play in international programmes in ensuring the involvement of end-users and in the dissemination of results. Organisations such as ours, operate at the interface between the science base, industry and Government, and can act as a catalyst for bringing the different parties together. We are also experienced in the pro-active dissemination of the results of scientific programmes and in transferring the outputs into best practice.

The enclosed appendix is an example of how current international collaboration might be expanded to improve the overall impact of technology based on satellites. A recent initiative by the Japanese Environment Agency is also appended to demonstrate how their satellite programme is being harnessed to environmental problems.

AN EXAMPLE OF HOW ENVIRONMENTAL RESEARCH MIGHT BE APPROACHED ON AN INTERNATIONAL BASIS: EARTH OBSERVATION—ENVIRONMENTAL MONITORING BY SATELLITE

BACKGROUND

The development of satellite remote sensing techniques has been carried out through a number of international programmes over the last 20 years. Not surprisingly, the outcome reflects the strengths and weaknesses of the international approach to R&D.

BENEFITS OF SATELLITE TECHNIQUES

AEA Technology plc has a significant terrestrially-based environmental monitoring business. It is unlikely that satellite-based systems could ever replace conventional terrestrial systems. However, it may be that satellite systems could add value to existing measurements and aid the cost effective deployment of existing instrumentation.

WHAT HAS BEEN ACHIEVED SO FAR

Clearly, it has been appropriate to develop satellite remote sensing techniques through international programmes—the financial and physical resources to develop the hardware are high, and the problems which can be addressed through earth observation are by definition global. However, the programmes have largely addressed issues that are of interest to the scientific community and the development of practical applications has been at best patchy, but with some notable successes in agricultural monitoring.

The three broad areas where earth observation is applied to environmental monitoring are land cover, ocean monitoring and atmospheric monitoring.

- *land cover*—the technology here is relatively well established and a number of commercially–oriented applications are developing. For AEA Technology plc there are a number of potentially exciting applications related to renewable energy—monitoring biofuels and for surveying prior to major hydro projects.
- *ocean monitoring*—the technology here is also relatively well established, but commercial applications are barely emerging. Some progress is being made in marine pollution monitoring. AEA Technology plc is working to define a role based around our close involvement with end–users thereby maximising the commercial applicability of future applications.
- *atmospheric monitoring*—the technology here is still under development and even conceptual applications are difficult to define. We have begun to consider how earth observation can support terrestrially–based measurements, but significant analysis of needs and likely applications is still required.

Over the past 12 months we have engaged in a dialogue with end–users (DoE etc), the science base (NERC, universities etc) and the remote sensing industry (NRSC, Logica) on environmental monitoring by satellites. Our role as a broker between the different parties has been welcomed. Clearly, there is significant potential for exploitation of space-based technology as the geographic footprint of environmental issues becomes larger.

AEA Technology plc is currently exploring its most appropriate role in this exciting sector and over the next 12 months hopes to become part of an EU or LINK project. However, genuine commercial opportunities are likely to be some way off, so whilst our objectives are necessarily medium to long–term, greater co–operation between interested parties may well accelerate the identification of appropriate applications and the development of suitable technology.

Letter to the Clerk of the Committee from Professor P J Diggle, the Royal Statistical Society (24.6.96)

The RSS welcomes the Science and Technology Committee's enquiry into environmental research in general, and the work of the NERC in particular. The Society believes the discipline of statistics is essential to the underpinning of the majority of environmental research and it is concerned at the lack of attention given to statistical issues within this area.

The Society recently submitted evidence to the Royal Commission on Environmental Pollution, and many of the points which we made in that specific context are equally relevant in the wider setting of environmental research. Statistics is concerned with the interpretation of data in the face of variation and uncertainty. But variation and uncertainty are pervasive in the environmental sciences: environmental processes are subject to natural variation, in geographical space and over time; environmental measurements are ncessarily imprecise by comparison with measurements made under controlled laboratory conditions; different groups of society, flora and fauna vary in their exposure to environmental pollutants, and in the severity of their response to a given exposure. Recent methodological research in environmental statistics explicitly addresses these issues of spatial and temporal variation, imprecise measurement and heterogeneity of response. In contrast, the statistical knowledge and awareness of many environmental researchers are confined to techniques appropriate to the analysis of simple, designed experiments.

We therefore suggest that the current review of the NERC research portfolio should consider adding to NERC's remit the support of research in statistical methodology relevant to environmental applications. This would ensure that environmental research is supported by the kind of innovative statistical approaches which are needed for the accurate modelling and efficient analysis of complex environmental processes, rather than relying on outmoded or inappropriate off-the-shelf statistical methods.

Because of the limited time available to us, these comments are necessarily brief and non-specific. However, we would be pleased to provide further information should you wish us to do so.

Memorandum submitted by The Natural History Museum (26.6.96)

INTRODUCTION

1. The Natural History Museum (NHM) is a Non-Departmental Public Body sponsored by the Department of National Heritage. The Museum houses unrivalled collections of over 68 million biological and geological specimens and the world's finest natural history library. Our mission is to maintain and develop our collections and use them to promote the discovery, understanding, responsible use and enjoyment of the natural world.

2. Of particular relevance in this context is the Museum's position as an international centre of excellence in systematics (see box), with some 300 scientific staff and 60 research students working in programmes of curation and research which address issues of current concern to science and society. These include biodiversity, environmental assessment and monitoring, earth materials, history and processes, and human origins. The 1992 report of the House of Lords Select Committee on Science and Technology on *Systematic*

Biology Research (ref. 1, paragraphs 3.24—3.25)[1] and the Government's response (ref. 2, paragraph 2)[2] both recognised the fundamental importance of systematics to pure research and its underpinning role in the environmental, agricultural, industrial, policy and other fields.

3. The Museum's budget in 1996–97 is £44.7 million, of which £13.4 million is for curation and research. The Museum has been able to apply on a competitive basis for research council grants since 1 August 1987. Of the six Research Councils, the Natural Environment Research Council is by far the most important source of income for the NHM.

4. We wish to make the following submission on those areas expected to be addressed by the Science and Technology Committee.

THE NERC RESEARCH PORTFOLIO

5. NERC's *1996 Corporate Plan* (ref. 3, p.6)[3] describes its research portfolio in terms of contributions to six major issues on the UK's environmental and natural resources agenda (page 6), one of which is biodiversity. The continuing development and application of systematic knowledge is essential to understanding the components of biodiversity, its distribution through time and space and the processes by which diversity is created, maintained or lost. However, the current corporate plan makes no mention of taxonomy or systematics. We welcome NERC's existing support for systematics provided through research grants and its five-year *Initiative in Taxonomic Research and Training,* a response to the Lords Select Committee report (ref.1). However, while appropriate in form, this support is too limited and has only (as yet) a short-term perspective.

6. The earth sciences clearly contribute in a major way to our understanding of broad environmental issues. We strongly support NERC's future plans to give greater encouragement, through funding initiatives, to multidisciplinary approaches involving the earth sciences to a range of environmental problems, such as sustainable resource development and soil quality.

7. Appropriate data records and information systems could play an important role in increasing the effectiveness and scope of the environmental research portfolio. In this context, we strongly support the commitment that NERC is now making to this area, particularly its target to develop an on-line Biodiversity Database. Continuing investment is needed to ensure that appropriate data sets are made truly accessible to potential users and to increase cost-effectiveness in the use of research funding for further gathering of biological data.

8. The importance of non-thematic funding for blue skies research is widely acknowledged, but there is continuing concern about the possible threat to this funding from an increase in resources allocated to individual initiatives undertaken by NERC. The present level of non-thematic funding should not, in our view, be further reduced, notwithstanding the value of such special initiatives.

THE INTERNATIONAL BASIS OF ENVIRONMENTAL RESEARCH

9. Much environmental research of value can be achieved at a national level or to meet national goals (for example, the UK Biodiversity Action Plan, ref.4)[4]. Increasingly, however, environmental issues are sufficiently pervasive or transboundary to require international resources or expertise. Taxonomic institutions such as The Natural History Museum are now discussing the best way to develop and share resources at both the national and international levels so as to tackle large-scale issues collaboratively and effectively.

FUNDING OF MAJOR ITEMS OF EQUIPMENT

10. NERC (and the other Research Councils) could usefully take a more proactive role in planning the provision of major items of research equipment at the regional and national levels. This should clearly be carried out in close collaboration with the national Higher Education Funding Councils, but should also give full consideration to the role played by research establishments outside the higher education sector. A more strategic approach to the funding of equipment, which encourages resource-sharing by institutions, would be an important contribution to maintaining the UK's scientific competitiveness in the face of increasing demands on the science budget.

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[1] *Systematic Biology Research.* Vol. 1-Report. 1991. Select Committee on Science and Technology. HL Paper 22-1 of 1991-92, HMSO.

[2] *Systematic Biology Research: Government Response.* 1993. Cm 2243, HMSO.

[3] *The Corporate Plan 1996.* 1996. The Natural Environment Research Council. ISBN 1 85531 158 5

[4] *Biodiversity: The UK Action Plan.* 1994. Cm 2428, HMSO.

WHAT IS SYSTEMATICS?

The science of systematics involves:

- discovering and describing the enormous diversity of living and fossil organisms, rocks and minerals;
- elucidating natural relationships; and
- constructing classifications that reflect these relationships.

Systematics creates a framework for all study of the natural world, allowing researchers to compare results from one study to the next. The classifications enable scientists to make predictions about the properties and geographic distribution of species and to uncover their evolutionary history. Systematics also provides the knowledge needed to discover and utilise natural resources and to conserve the Earth's biological diversity.

Memorandum submitted by the Institute of Biology (1.7.96)

The Institute of Biology—as the independent charitable body charged by Royal Charter to represent UK biologists and biology, and which is affiliated to some 75 specialist life science societies—is ideally placed to respond to the above consultation.

GENERAL COMMENTS REGARDING THE REVIEW

While the Institute in principle welcomes measures to improve the efficiency with which public finance is used on science research, it is greatly concerned that recent years have seen this sector come under prolonged and considerable scrutiny together with re-organization. The Institute appreciates that scrutiny and re-organization is inevitable in a sector that should be publicly accountable, however prolonging such activity incurs a cost, detracts from long term strategy, hinders the development of scientists' careers and lines of research: in short it lowers efficiency. The Institute would remind the Science and Technology Committee that it has been just three short years since the publication of the Government's White Paper on Science[1] and that currently the Public Sector Research Establishments—including those related to the NERC—are undergoing their second review in the Prior Options exercise. UK Public Sector science, of which NERC is a part, is in urgent need of a period of stability and a chance to achieve the goals it has only recently been set.

FUNDING

The Institute requests that the Science and Technology Committee notes that the UK Public Sector science, in terms of published papers, citation indices, and international awards per unit of expenditure, is internationally competitive. The UK (including private spend) spends less on science research as a percentage of GDP than Germany, France, Japan and the USA[2].

The Institute requests that the Science and Technology Committee notes that the proportion of the above total expenditure financed by Government in the UK is less than that in Germany, France, Italy, Japan, and the US[2].

The Institute requests that the Science and Technology Committee notes that with regard to NERC's funding, while the Science Budget (the Government finance given directly to the Research Councils) has in real terms remained constant, the direct and indirect effects of the overall decline in the Government's support for science—of some 16 per cent in real terms over the past decade—has had a detrimental effect on NERC research. Much of this decline has been due to cuts in funding through Government departments. Furthermore, if the Government's current proposals are to be realised, there will be additional future loss of support due to the planned cuts in Higher Education funding[2]. (These will be realised in many ways, for instance equipment used for teaching can also be used for research, hence a loss of the former will affect the latter.)

The Institute is of the view that while the Government and public has every right, indeed duty, to expect British scientists to be as productive as those of any other nations's, gross productivity (in terms of the above criteria), cannot be expected to be better than our international counterparts without comparative funding.

NERC RESEARCH PORTFOLIO

With regard to NERC's role. The area of research for which it is responsible—the natural environment—is of great value to the UK, both in direct terms—the cash value of the natural environment (be it land, aquifer, forest, whatever...)—and indirect terms (the economic value of the environment as a sink for industry and commerce's waste products and the internal and external heritage value (commonly realised through such activities as tourism). Furthermore NERC international work—such as on ocean cycles and atmospheric physics—is of value as these have a direct relationship with our nation's economic activity (ex: that relating to the burning of fossil fuels). The Institute is therefore of the view that Governmental support for the NERC should continue, and that an estimate of the loss in funding (both direct and indirect) due to the cuts in Departmental R&D expenditure and forthcoming HEFC expenditure to the areas of NERC research be made. This shortfall should be addressed as a matter of strategic importance to the UK.

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[1] OST (1993) *Realising our potential—A strategy for science, engineering and technology.* (Cmnd 2250). HMSO: London.

[2] DTI (1996 *Science, engineering and technology statistics 1996.* Cmnd 3257-11. HMSO: London.

With regards to NERC's research portfolio in detail, following the Government's White Paper, and given that NERC is participating in the Technology Foresight exercise, the Institute of Biology sees no benefit in re-appraising the NERC research portfolio at this time. Any such meaningful reappraisal, without additional resources provided, will have a detrimental effect on NERC activities. However notwithstanding the afore, the Institute is mindful of NERC's original Charter which states that its function was "to encourage, plan and execute research in those sciences, physical and biological, that relate to Man's natural environment and resources. Such investigations provide a better understanding not only of the nature and processes of the environment in which we live and on whose resources we depend, but also of their influence on man's activities and, of growing importance today, of Man's influence on them". The importance of NERC was that it maintained a body of expertise and scientific capability independent of policy-advocating departments and agencies. The Institute of Biology considers that that independence has been jeopardised by the increasing weight given to the Rothschild principle of the customer-contractor relationship. One consequence of this loss of independence of scientific planning and thinking, further augmented by the overall decline in governmental support for science has been the failure of Government to be able to respond meaningfully to issues the comprehension of which depends on long-term basic research. The Institute therefore considers it most important that the NERC's independence be restored through assured funding that contains an allowance for the decline in overhead support from other areas of Governmental science funding to those institutions that conduct both NERC and non-NERC research.

Memorandum submitted by the Council of Science and Technology Institutes (3.7.96)

INTRODUCTION

The Council of Science and Technology Institutes (CSTI) represents the common interests of its member institutions which are the major scientific professional bodies—the following bodies are CSTI members:

Institute of Biology
Royal Society of Chemistry
Association of Clinical Biochemists
Institute of Environmental Sciences
Institute of Food Science and Technology
Geological Society
Institute of Mathematics and its Applications
Institute of Physics
Institute of Physics and Engineering in Medicines and Biology

CSTI exists to provide, in the public interest, collective representation of the member institutes embodying the community of professional scientists and technologists in the UK.

CSTI welcomes the opportunity to make its views known to the Committee as it deliberates a very important aspect of UK science and technology.

FUNDING

It is impossible to divorce the issue of overall funding from the specifics of the NERC situation. CSTI welcomes the fact that the Science Budget, in general, and the NERC Budget, in particular, has been maintained in real terms. However, there have been significant cuts in the research budgets of Government Departments and also in the HEFC funding. These cuts inevitably impact on the work of the NERC. As is widely recognised, the UK total expenditure on scientific research is a smaller percentage of GDP than our major competitive countries such as the USA, Germany and Japan.

RESEARCH PORTFOLIO

In its 1996 Corporate Plan, the NERC divides its research priorities into four main areas namely Environmental and National Resources Issues, Research to Benefit Industry, Research to Respond to Scientific Challenges for the next five to 10 years and Environmental Foresight Topics. CSTI believes that the coverage is both comprehensive and appropriate to the needs.

Major activities, supported by NERC, such as the British Geological Survey, the Ocean Cycle work, the British Antarctic Survey and the studies in atmospheric chemistry and physics are of great significance both nationally and internationally and need the assurance of long term support.

It is too early to evaluate the impact of Technology Foresight on the direction of the NERC programmes. However, it is our view that the NERC should protect and strengthen the long term work. For example, in atmospheric science, there is increasing pressure for the DoE and the Meteorological Office to direct their funding, leaving the support of the more basic aspects of research to the NERC budget. The NERC does fund atmospheric physics and chemistry research, primarily in University sector but, possibly because of the global nature of much of this research, users are reluctant to provide significant additional funding thus increasing the pressure on the NERC budgets. In the past, atmospheric science had its underpinning research funding provided by the SERC but it is difficult to see why SERC's main successor body, the EPSRC, should fund such research as the responsibility was handed over to the NERC.

ORGANISATION

Some two years ago, a new management structure was introduced and it is perhaps too early to judge its success although it appears to be working well. The NERC has a very difficult task in trying to balance the funding of research in such a broad area as the natural environment and there are no "right answers". As indicated above, one of the CSTI's chief concerns is that the organisation recognises the need to protect the "responsive mode" funding and does not allow the necessary complex structure needed to deal with major international projects to operate to the detriment of the basic research on which such work is ultimately dependent.

Following the Government's White Paper on Science and the Technology Foresight Exercise, the NERC and the Research Council, have adapted their organisational structures without serious disruption to the science and it would seem reasonable to seek a period of stability. Research is essentially a long-term activity and too frequent "re-organisations" are unhelpful.

Memorandum submitted by the Institution of Professionals, Managers and Specialists (11.7.96)

1. INTRODUCTION

The Institution of Professionals, Managers and Specialists (IPMS) is a trade union which represents 80,000 scientific, technical and specialist staff in the Civil Service and related bodies and major companies. In particular, IPMS represents the specialist staff (eg scientists, engineers and technicians) of the Natural Environment Research Council (NERC).

2. The submission will attempt to put the perspective of the specialist who is employed within NERC on the key points that the committee is expected to address ie

- review of the NERC research portfolio
- the extent to which environmental research is best approached on an international basis
- the funding available to NERC from sources (including government sources) other than the science budget
- the funding of major items of equipment.

Additionally this submission will also highlight some problems we perceive within the current organisation.

3. It is likely that some of what is said in this submission may have to be altered in the light of the results of the deliberations of other bodies that are currently reviewing NERC. Of particular importance in this regard are the Prior Options Reviews being conducted on the British Geological Survey (BGS), the Centre for Coastal and Marine Sciences (CCMS), and the Centre for Ecology and Hydrology (CEH). These reviews are due to be completed and reports submitted to ministers by the end of July.

4. NERC RESEARCH PORTFOLIO

From its beginning in the mid 1960s the remit of NERC as the lead agency in the UK for research and survey across the whole spectrum of the natural environment sciences has been huge. The selection of how much effort should be expended in any one particular area of scientific research has been the subject of constant review since. The boundaries within which NERC operates have also been subject to scrutiny from time to time.

5. The Science White Paper "Realising our Potential" confirmed the continued existence of NERC. The consequent boundary study of Sir David Phillips recommended some increase to the areas of research conducted by NERC, to include:

- Natural Resource Management
- Pollution in relation to Human Health
- Understanding and Protection of biodiversity
- Waste Management
- Environmental Risks and Hazards

6. IPMS welcomed these conclusions at the time and currently sees no evidence that a change to these boundaries is necessary. Questions require addressing as to how NERC organises itself within these boundaries viz:

(i) The balance between "wealth creation" and "quality of life", and

(ii) the balance between research carried out in HEIs and NERC establishments.

Since the Science White Paper the perception has arisen that the balance has moved away from "quality of life" and much more effort is being expended on "near-market" industrial research. This shift is independent of whether it be funded by industry or by the concept of "Thematic Funding" being introduced by NERC as a way of utilising OST funds. It is the view of IPMS that industry does not want NERC to do this type of work at the expense of the other parts of its remit. Industry is in a better position to determine what opportunities it is appropriate for it to take up. NERC should focus in long term issues: basic research that industry will not fund but out of which important information and technologies may emerge in the future.

7. IPMS believes that continuity is particularly important in the activities of NERC which are self evidently of a long term nature. Security of funding and freedom from apparently constant contractual and organisational upheaval are required to enable such activity to flourish within its own research environment.

8. The Extent to which Environmental Research is Best Approached on an International Basis

Almost all of the scientific effort of NERC has an international slant. The work of the freshwater and terrestrial ecologists is studied by colleagues working on similar ecosystems the world over; the work of the BGS is not confined to studying the UK landmass but extends to the continental shelf and well beyond; and the work of the oceanographers at the Southampton Oceanographic Centre (SOC) and within the CCMS can only be described as being "global" and thus international. Similarly, research conducted by the British Antarctic Survey (BAS) will assist in providing understanding of the interactions between land, sea and air on a global level.

9. In a prefect world perhaps all research into the environment would be conducted and funded on an international basis. However, the remit of the NERC has must additionally allow issues which may effect the national interest to be studied. Work of a truly international nature is often governed by international treaty, and the funding of such research can often have a knock-on effect on other research programmes in times of financial stringency. The "ring fencing" of the BAS budget may have had a detrimental effect on the remainder of NERC research portfolio, but were the UK not to play a full part in the Antarctic Research effort we would not be in the best position to benefit from such research. Therefore the continuation of such international ventures is necessary.

10. On the less dramatic scale the ability and capability of NERC scientists to contribute to the research and/or survey effort funded by and in other countries also benefits both the country which commissions the research and the UK.

11. NERC and its constituent parts need to be able to do research which is of international importance and the funding of such work should be from the UK as well as overseas.

12. The Funding of Major Items of Equipment

The need for NERC to buy major items of scientific equipment is a logical consequence of the remit the UK government has given it. There are several flaws with the way the current financial system is organised that have the potential to cause problems when major items of equipment need to be purchased. As with most, if not all, government funded organisations the "current account" financial regime can mean that when it is necessary to fund the replacement of a major item of equipment, NERC is often faced with the situation where that funding causes the need for cutbacks in other parts of its research effort.

13. Attempts have been made to make the accounting system more "business like" which can have the effect that capital assets are left underutilised. An example of the type of difficulty of having a hybrid public sector/private sector costing regime can give is the underutilisation of research vessels. NERC owns a small fleet of such vessels yet their running costs are not centrally funded. Instead, individual research programmes must raise the funds for their services, making such projects very expensive, often too expensive to be funded from OST budgets. The result is that scientific cruises can only go ahead if sufficient funding from outside sources can be found to subsidise the strategic research that OST funds.

14. Funding From Sources Other Than OST

Much of the scientific endeavour of NERC is long term in nature and must therefore have long term security of funding. The current structure of the machinery of government means that long term funding comes from the science budget of OST. In addition to this long term funding other opportunities arise for NERC to take advantage of its position to take on commissioned research from other sources. The work carried out from such commissioned income should fall within the boundaries of the NERC remit. If this were not the case it would be inappropriate for a publicly funded organisation to do the work.

15. Lack of long term financial security due to insufficient central funding has made all NERC establishments more and more dependent on funding from sources other than OST. Whilst commissioned research from other government departments is a wholly appropriate way for NERC to be funded caution must be exercised in taking commissions from the private sector. The independence with which the NERC's research is viewed will come into question if it is seen as being "in the pocket" of any particular interest group. For example the authoritative report produced by NERC on the disposal of the Brent Spar would have been called into question were its funding to have been viewed as coming in large part from the oil industry.

16. As well as the problem relating the need for NERC to be perceived as an independent organisation there are other problems relating to funding and data donation from other sources.

Time taken in pursuing contract funding is time not being taken up in scientific research. It is difficult to be absolutely certain in setting limits as to how much effort, funded by the OST, should be expended in attracting scientific commissions. At the extreme it is effort well spent if customers beat a path to the door of NERC to ask for work appropriate to NERC, to be undertaken—little time or effort exerted and an increase to the coffers of NERC. However, the real world is not like that and considerable effort has to be made in securing such funding. The cost of that overhead is a price worth paying if the funding comes in. However, much of the work industry wants done is of a very short term nature and then the value of the effort must be questioned.

NERC supports seven Data Centres which are national repositories for environmental information and data. As well as internally generated data the Centres hold large amounts of data donated on a voluntary basis by industry and local and national organisations. It is likely that should NERC begin to compete with its current customers in their areas of work this voluntary donation of data will cease and such environmental data may be lost from industry and the public.

17. IPMS believes that if NERC were funded to an appropriate level from the public purse it would be in a position to answer many of industry's questions without the need to expend effort in "marketing" itself as a research contractor.

18. Short Termism

The previous paragraphs in this submission have attempted to highlight some of the concerns NERC researchers have with regard to the research NERC conducts and the manner in which it is organised to fulfill that function. These issues are dear to the heart to the IPMS membership within NERC but the major issue which concerns them is the apparent lack of long term commitment to their work, and therefore to them from the Government. IPMS believes that the research portfolio of NERC is of such a nature that it must be carried out by committed highly motivated professionals working in properly equipped establishments and who view their employment prospects as secure. That such a lot is not one which the majority of NERC employees enjoy is to be deplored.

19. Many of the problems NERC has faced and is facing relate to the current political imperative that does not allow a long term financial commitment to be given to organisations which spend public funds, despite the public's perception that such spending is necessary. The effects of the lack of long term funding is exaggerated by frequent changes in scientific goals inspired from on high, funding priorities changing, ring fencing of certain projects when they are in the public eye with a high profile, and changes to the post holders of senior management (because of that Government's insistence that such posts are filled on short term contracts). NERC researchers are expected to plan their science in terms of five year plans, a timescale which is rarely appropriate. Some activities (eg ice core analysis, climate change, petrochemical drilling monitoring) requires the build up of expertise in people and complex equipment over periods substantially longer than five years. Other projects in leading edge science require a more flexible approach and planning such work on a five year cycle is overly restrictive.

20. To maintain a high scientific standard, NERC must employ and retain high calibre scientists. Rewards for working within NERC are increasingly hard to find. The level of remuneration is not particularly high, and concerns about job insecurity are on the increase. Over the years there has been an increase in the number of staff on short term appointments. This type of employment was introduced to allow NERC to take on staff to do work which was not envisaged as being long term in nature and for which long term funding had not been secured. However, the use of this employment practice is now out of control, with staff on such contracts having them renewed several times and the proposal that all new research posts should in future be initially on a fixed term basis. The practice of retaining staff on repeated short term contracts is morally indefensible, and only achieved by exploiting a loophole in employment law. Staff who have shown a long term commitment to NERC should be rewarded in turn by a commitment from NERC.

21. Whilst not enjoying security of tenure the majority of short term contracts in NERC at least have their service in NERC to count for superannuation purposes. Even that privilege is not afforded to all of them: researchers who are employed on what is known as a "BAS" contract do not have a superannuation scheme. Such contracts were historically used for staff who overwintered in Antarctica and who would spend little of their time in the UK. That a special contract was devised to suit that unusual working environment is not surprising. What is surprising is why it was found necessary to exclude such employees from the

superannuation scheme. Even more surprising is that now BAS uses such contracts for staff who spend most of their time in the UK and only go to the Antarctic for a summer season. IPMS believes the use of such contracts is the act of an employer who cares little for the future well being of its staff.

22. How can this situation encourage the best graduates and post-graduates to join NERC? NERC may not have an immediate recruitment problem, but it cannot expect to recruit the best scientists if it does not offer an attractive employment prospect—with long term security and with comparable pay and conditions to similarly qualified and experienced scientists in the private sector.

Additional to the future prospects of NERC to employ the best scientific brains, the ability of the nation to encourage some of its most able school children into choosing science as a career option will be diminished by the perception that the scientific worker is undervalued and underpaid by the UK Government.

23. CONCLUSION

As our knowledge of the interactions between land, sea and air has increased it has become more apparent how man's activities can disturb them. Any disruption to their fragile balance could effect the well-being of the UK. Such perturbations might effect the climate, our ability to utilise natural resources both geochemical and biological, or human health by increased incidence of pollutants.

Such changes could have enormous consequences, both in the long term and the short term. It is therefore essential that the UK retains an independent, long term, strategic, environmental science effort. Such an effort requires well motivated scientists working in research establishments that have secure long term funding that is as independent as is practicable of commercial interest, that can provide independent advice based on an understanding of the underlying scientific processes. Of necessity this long term strategic effort requires a commitment of similar timescale in funding allocation from the UK Government. There is a real threat to the ability of the NERC Institutes to fulfill that role if the current lack of long term financial commitment to NERC scientific effort continues.

Letter submitted by Professor J R Krebs, Natural Environment Research Council (20.11.96)

Thank you for your letter of 17 October which invited comments on arrangements for collaboration and co-ordination of climate research. I am grateful to you for enclosing a copy of the Memorandum from the Meteorological Office; I have also seen a copy of "The Climate Agenda".

CLIMATE RESEARCH

The Memorandum from the Meteorological Office is right to identify the Inter-Agency Committee on Global Environmental Change (IACGEC) as the body with responsibility for national co-ordination of global environmental change science and technology. IACGEC reports to the Chief Scientific Adviser and Head of OST, Sir Robert May FRS.

Although IACGEC has no executive powers, it provides an effective mechanism for Departmental and Research Council co-ordination and liaison on issues relating to global environmental change, including climate research. The recent (June 1996) publication of the UK National Strategy for Global Environmental Research (GER) demonstrates the strategic approach adopted by the Committee.

IACGEC operates the principle of "lead agency responsibility". This may translate into unilateral, bilateral or multilateral action, depending on the nature of the issue. Through IACGEC, agencies are able to discuss and agree who will lead on specific actions.

IACGEC played a useful part in formulating the initial UK position on the "The Climate Agenda". In this instance, the Office of Science and Technology (an observer member of IACGEC) took the lead in formulating the UK line, in consultation with other IACGEC members. NERC, was therefore, able to ensure that its concerns fed into the UK line developed for Professor Julian Hunt to take to the WMO Congress in June 1995. NERC's policy on sponsoring international programmes is to do so where they are scientifically justified. By adopting this approach we ensure that proposals are rigorously reviewed against national requirements.

The Secretariat for IACGEC is provided by the UK's GER Office which is located within the Research Council's Swindon Office. NERC is the largest sponsor of the GER Office, which in addition to servicing IACGEC acts as a national and international focus for information exchange on GER science and technology.

METEOROLOGICAL RESEARCH FLIGHT

The Memorandum from the Meteorological Office outlines the funding and future of the Meteorological Research Flight (MRF) C-130 Hercules aircraft. In 1995, NERC Council endorsed the conclusions of the NERC Expert Review "Requirements for Airborne Platforms" (1994) that the NERC research community requires access to a large, long-range pressurised turboprop aircraft with the ability to operate throughout the troposphere to undertake chemical and dynamical research. The MRF C-130 aircraft is the only aircraft of this type operating in Europe.

NERC has had formal access to this platform since 1991 and NERC researchers have made increasingly successful use of this facility. In addition to direct access, NERC researchers collaborate with the Meteorological Office through the Joint Centre for Mesoscale Meteorology at Reading University. The NERC Atmospheric Sciences community is also involved in international programmes which require C-130 time.

During the period of use of the C-130 by NERC-funded scientists, the onboard instrumentation has been extended and considerably improved. As a result of this investment, partly by NERC, the aircraft is one of the best platforms worldwide for studies of the chemistry and physics of the troposphere. It enables British scientists to take part in large international experiments concerned with various aspects of meteorology and climate. NOAA and NCAR are sufficiently impressed with UK activities they intend to deploy two aircraft to Europe to participate in a joint programme in 1997.

Prior to 1995 this service was gratis to NERC. The changing status of the Meteorological Office has resulted in charges of £2,000 (+VAT) per flying hour being imposed in 1995–96 rising to £6,000 (+VAT) per hour in 1996–97, which represents the full cost determined by DTEO Boscombe Down. This rapid change has put unacceptable pressure on NERC aircraft access and has caused difficulties with the planning of thematic programmes. We estimate that over the three year period commencing April 1997, demand for C-130 time could cost NERC £2.1 million. Current emergency allocations from Council's own baseline are at the level of £300,000 per annum, whilst demand, as measured by alpha–4 and above proposals is expected to exceed £850,000 in 1997–98 alone.

NERC has investigated the potential of Dual-Use LINK as a means of funding, but has been advised that at this stage the mechanism is not appropriate. The Select Committee should be aware that NERC has no identified funds to support this activity and is unable to make any long-term contribution from its existing resource base. It is possible therefore, that the UK core capacity in Atmospheric Science will decline over the next five years.

I trust that the above comments are helpful. Please let me know if I can assist the Committee further.

Letter submitted by Professor John Harris, Imperial College of Science, Technology and Medicine (3.12.96)

As promised, I enclose my comments on the Met Office submission to your Committee on the Inquiry into the NERC. As David Carson explained, I believe, these comments are submitted on a personal basis, against the background of involvement in the Royal Meteorological Society as President and now Vice-President.

COMMENTS ON THE METEOROLOGICAL OFFICE SUBMISSION TO THE INQUIRY INTO THE NERC

1. The description of the programme and role of the Meteorological Office is generally valid, though it does, not surprisingly, read as a slightly "MO-centric" view of the world! Nevertheless, the Meteorological Office is an important and central element of the UK R&D meteorology and atmospheric science community. The Meteorological Office contains a large fraction of the available expertise in the country. The picture you should have is of a large, but benevolent "giant" within the atmospheric science community, with a relatively small number (c.10) of good (ie internationally competitive) university groups scattered around the country, the latter supported principally by NERC, but receiving some funding through contracts and grants from the Meteorological Office.

2. The relationship between the Meteorological Office and NERC is indeed good. There is overlap but little duplication of programmes. However, the scales of resource should be appreciated: NERC puts about £5 million per year directly into atmospheric science, plus another few million pounds through separately funded satellite projects: maybe £8 million per year in all. The Meteorological Office R&D programme (which ranges from the highly applied to the fairly esoteric) includes over 200 people, which must cost easily £10 million per year in staff costs alone. With satellite expenditure at (order of) about £10 million per year, and other non-staff costs, I imagine that the total R&D budget (ie not direct observations and forecasting) is approaching £25 million per year. The DoE spend through the Hadley Centre adds a further amount of about £7 million, ie over £30 million in all, or about four times that in NERC.

3. The Hadley Centre is, undoubtedly, a world-class centre,which does build on the core of R&D which existed in the Meteorological Office to start with. However, there are a few (c. 3) university groups which have an equal standing in research terms (though with much less comprehensive programmes). Links with the rest of the research community are quite good, but I believe that more could be done to communicate with the rest of the community: the statement at the bottom of page 26/top page 27 is a little "OTT".

4. It could be argued that the Meteorological Office ought to make more use of the university community, by contracting out considerably more R&D. This would bolster and strengthen the universities, where truly basic research is perhaps best done, and might also prove more cost-effective for the Meteorological Office (rates are lower in universities because we use research students and post-docs; also, the Meteorological Office

would need to employ fewer full time staff). In the limit, some argue that the whole of the Meteorological Office R&D programme could be split off, and a separate research institute formed: however, I am not amongst these; I believe the Meteorological Office does need its own, closely integrated R&D programme, in the most intimate contact with its operational work.

5. In conclusion, my principal points are:

(i) The Meteorological Office R&D programme is, indeed, of very high quality; its best elements are of the same sort of high quality as the best university research groups, and both are internationally highly competitive.

(ii) Links between the NERC-funded university community and the Meteorological Office are good in places, but complacency should not creep in: they could be even better.

(iii) The boundary between the Meteorological Office programme and the NERC programme in atmospheric science might be pushed towards NERC, for example by contracting out more to universities.

Letter submitted by the Office of Science and Technology (2.1.97)

Thank you for your letter of 2 December 1996 about the Inter Agency Committee on Global Environmental Change (IACGEC).

The Government Chief Scientific Adviser has overall responsibility for this Committee and OST has observer status on it. When the Committee produced the National Strategy for Global Environmental Research in June 1996 it fulfilled the key element of its 1993 remit. We are now in the process of reviewing its past performance and the possible future role and structure for a successor body. Some of the evidence that the Select Committee received may have reflected this transitional situation. We expect to complete the review this month.

I enclose a list of the Chairman, members and Secretary of IACGEC as it was constituted when it last met on 24 May 1996 (but updated to give the current Chief Executives of Research Councils): Sir Robert May would need to appoint a new chairman to any similar successor committee.

INTER-AGENCY COMMITTEE ON GLOBAL ENVIRONMENTAL CHANGE

IACGEC Members

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Chief Executive
Economic and Social Research Council

Professor Raymond Baker
Chief Executive
Biology and Biological Sciences Research Council

Mr Derek Davis
Director-General
British National Space Centre

Dr David Fisk
Chief Scientist
Department of the Environment

Professor Richard Brook
Chief Executive
Engineering and Physical Sciences Research Council

Professor Julian Hunt
Chief Executive
Meteorological Office

Professor John Krebs
Chief Executive
Natural Environment Research Council

Professor George Radda
Chief Executive
Medical Research Council

Observer

Mrs Helen Williams
Director, Trans-Departmental S&T
Office of Science and Technology, DTI

Chairman (until July 1996)

Professor Sir Ronald Oxburgh
Rector
Imperial College of Science, Technology and Medicine

Secretary

Mr Stephen Morgan
The UK Global Environmental Research Office

Letter to the Committee Assistant from Professor Julian Hunt, FRS (31.1.97)

You wrote on 18 January requesting details of the cost of the C130 aircraft since 1990 and projections into future years.

Prior to Financial Year 1996–97 full costs of operating the C130 were distributed between the Met Office and the RAF. It is therefore difficult to give precise costs for past years without considerable effort. In fact the costing basis has remained fairly constant and the current annual operating cost of about £3,242,000 can be taken as a typical average annual figure in 1996 prices. The figure allows for the average effect of the major overhaul of the aircraft which occurs at intervals of six years. the next major overhaul is due in 1998 when the actual expenditure for the year will be around £4 million. The mechanisms of resource accounting should allow this extra cost to be met by a level funding of £3,242,000 over the next few years beyond 1998.

Prior to the Financial Year 1996–97 all costs were met from the combination of Met Office and RAF funds. Our estimate of the available funds from the Met Office for future financial years (in 1996 prices) are:

96–97	*97–98*	*98–99*	*99–99*	*00–01*	*01–02*
£2842K	£2242K	£2142K	£1923K	£1823K	£1823K

It should however be noted that over 80 per cent of these funds arise within the Met Office CORE customer contract and fall to MoD and other government departments who are liable to seek around 3 per cent savings each year. Thus funds in for example 2001 or 2002 may well be 15 per cent less. There is also the separate issue of the CORE customers balancing the allocation to the C130 against other activities. It is important to remember that the C130 falls within the parts of trading fund which are at our customers' discretion. We do however expect to represent the importance of the C130 to those customers.

You will see from the above that there is an increasing shortfall in C130 funding within our budget. For 96–97 and 97–98 we have a good expectation of this being largely met by NERC and European Union use. For subsequent years we hope that such funding will meet the shortfall but of course have no guarantee of this. There is however also the opportunity of possible use of the C130 by others such as DERA, but this has still not been agreed.

I hope this information meets the Committee's need.

Professor J C R Hunt FRS,
Chief Executive

Letter to the Clerk of the Committee from Professor John Krebs, FRS, Chief Executive of the Natural Environment Research Council (3.2.97)

I am writing in reply to your letter of 10 January with some further comments on the various points you raise.

EARTH OBSERVATION

Discussions on future funding of Earth Observation are still in progress. The point that I would wish to make is that if there is any intention that NERC should, for example, assist in supporting the European Space Agency Earth Observation programme in recognition of the science benefits from this programme, this would be a new development with substantial funding implications.

ATTRIBUTION FOR EU PROGRAMMES

There was a very major shift in attributions last year for the Environment and Climate programme between OST and DoE, with OST accepting a fourfold increase from 7.6 per cent to 28 per cent. There was also a DoE to OST shift of 7.5 per cent within the Marine Science and Technology programme.

Discussions on proposals from DoE to further increase the OST share of the Environment and Climate programme are still in progress. The proposal is being resisted in the light of the major rebalancing agreed last year.

At present it is correct to say that attribution is borne at the level of the OST as a whole.

WITHDRAWAL OF GOVERNMENT DEPARTMENT SUPPORT

I do not think I could cite any areas where NERC has had to widen its remit in response to withdrawal of a department from an area of research previously seen as its responsibility. The two examples quoted in my earlier letter related to withdrawal of a previous offer of co-funding, which led to some immediate difficulties in a new programme, and some knock-on effects of changes in the DTI hydrocarbon commission with the BGS.

Support for Non-thematic Research

As you have noted, the latest NERC Annual Report shows that in 1995–96, 18.8 per cent of the Science Budget went to non-thematic funding. I would point out that this includes both research (11.2 per cent) and training (7.6 per cent). Also that this is the actual spend in that year. The figure of 20 per cent quoted in my letter of 26 April, and analysed further in response to Question 3 of your questionnaire (page 7 of the NERC input), reflects the 1996–97 planning figure of 20.2 per cent.

There will always be some year on year fluctuations, reflecting the fact that shiptime and other fieldwork costs associated with non-thematic support will not be a constant factor; they will vary from year to year depending on the activities being supported. The increase in 1996–97 over the 1995–96 figure can also be in part explained by the introduction of the MRes (which would account for about £0.5m) and an increase in the Research Training and Support Grant.

As I indicated in my letter, it is very unlikely that Council would wish to see any reduction in the present level of non-thematic support. Indeed you will no doubt have seen from the Science Budget settlement that the Research Councils have again been asked by the OST to make responsive mode funding and studentships (NERC non-thematic support) priorities.

However, Council has yet to take a firm view on the actual desirable level of spend. This will be considered following completion of the Portfolio Planning process mentioned in the earlier NERC inputs, which will report in Spring 1997. The outcome of this review will feed into the development of strategies by the Council's Science and Technology Boards in the Summer and an overall NERC strategy in Autumn 1997.

Met Office Research Flight

NERC's principal airborne requirement for atmospheric science is for a platform or platforms with an endurance of nine hours or more, capable of carrying the large payloads of chemical and physical instrumentation needed for sampling and measurement from 50 feet to the tropopause at c 30,000 feet. Above about 20,000 feet the plane has to be pressurised. There are clear benefits in being able to profile throughout this height range with the same platform and instrument fit.

It is not possible to answer your question without knowing about the capabilities that a "more modest turbo-prop" would offer. All we can say is that at present the Hercules is the only platform currently operating in Europe able to fulfil our requirements. There would be a substantial impact on the UK atmospheric science capability if no comparable platform were available.

Letter to the Clerk of the Committee from the Department of Trade and Industry (4.2.97)

BOREHOLE DATA AND THE BRITISH GEOLOGICAL SURVEY (BGS)

You wrote to Mr Fincham of FRM at DTI on 14 January about the above, a copy of your letter has reached me via the Office of Science and Technology since it raises issues concerning my responsibilities.

What NERC has told you is substantially correct. A condition of the grant of a licence is for the licence holder to provide copies of all data acquired under the licence to the Secretary of State.

Up until 1993 the BGS managed the DTI Core Store in Gilmerton and provided interpretation services for the Oil and Gas Division Branch 2, and BGS staff working on projects for DTI had pre-sight of data—but only in so far as was provided in accordance with licence terms. Availability of hydrocarbon data to other parts of BGS has never been the norm, although in practice we did allow data to be included for the offshore regional mapping programme (now completed) by agreement with licensees.

In 1993, 5 contracts for services to OG2 were market tested. BGS applied along with others and retained their interpretation services work. The 5 contracts were awarded as follows:

Geological Advice	—	BGS (NERC)
Core Storage	—	Hays Business Services
Computer Support	—	Spectrum Energy
Core Analysis	—	SPT, now Robertsons
Computer Software Development (1 year)	—	Logica

In the event BGS was awarded the contract for Geological Advice and staff from this group do access data from the Core Store relating to projects upon which they are working for us. So in this regard the situation is unchanged.

However, it was a precondition of the United Kingdom Offshore Operators' Association (UKOOA) for the market test to proceed, that data continued to be received by DTI and it was noted at the time that BGS was a competitor in the oil and gas consultant market and that DTI should not favour one consultant over another by allowing BGS unfettered access to data less than 5 years old.

Under the 1926 Mines and Quarries Act, the Geological Survey of England and Wales, and of Scotland, and its successors—now the British Geological Survey, is entitled to receive the copies of results (and samples from) all onshore boreholes drilled for any reason—this includes (the very few) wells drilled for hydrocarbons under DTI licences. The British Geological Survey is also notified of all drilling onshore.

As a matter of convenience licensees send copies of borehole electric logs to BGS at Keyworth, but send all core material to the DTI Core Store in Edinburgh where it is kept confidential for five years after which time it is transported to Keyworth. Whilst at Gilmerton, BGS staff are granted free unfettered access to core from these landward wells. The arrangement works well and we regularly discuss holdings and have provided BGS with a list of offshore core and cutting material held. The BGS thus knows the location and extent of all these data held.

I hope the above explains the reasons for the *status quo*. The key aim is to conserve data from hydrocarbon exploration and production offshore and to make it available for study after the release period in a variety of forms and formats so as to allow studies in the future which will lead to further discoveries of oil and gas and for a better understanding of the geology of the UK and western Europe.

It is not a question of the recognition of the National Geoscience Information Service but the recognition that all data cannot physically be held at a single location and to best protect it it may be better for it to be in a variety of locations with the onus on the petroleum licensees and the regulator to play their parts in conserving that information.

I can assure your Committee that no data is lost and that the facilities provided at Gilmerton for viewing offshore data are second to none.

I should not close without mentioning colleagues at Keyworth in BGS with whom we have very good relations. We are after all working towards the same end. In practice it is rare for BGS to seek offshore data from DTI and they would normally approach the operator. I do not know of a request being turned down.

I hope the above answers your questions and I trust I have set these in a much more wider context of hydrocarbon exploration and production and the need to make publicly available this data for further use.

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